January 6, 1958 75 Cents

AVIATION WEEK

A McGRAW-HILL PUBLICATION

Ford Subsidiary's Space Study Grows

•

B-58 Photo Pod Design Described

S-58 Airlift in Algeria

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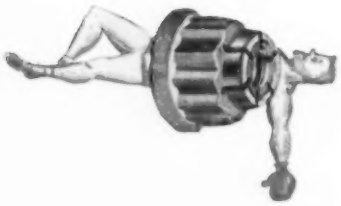
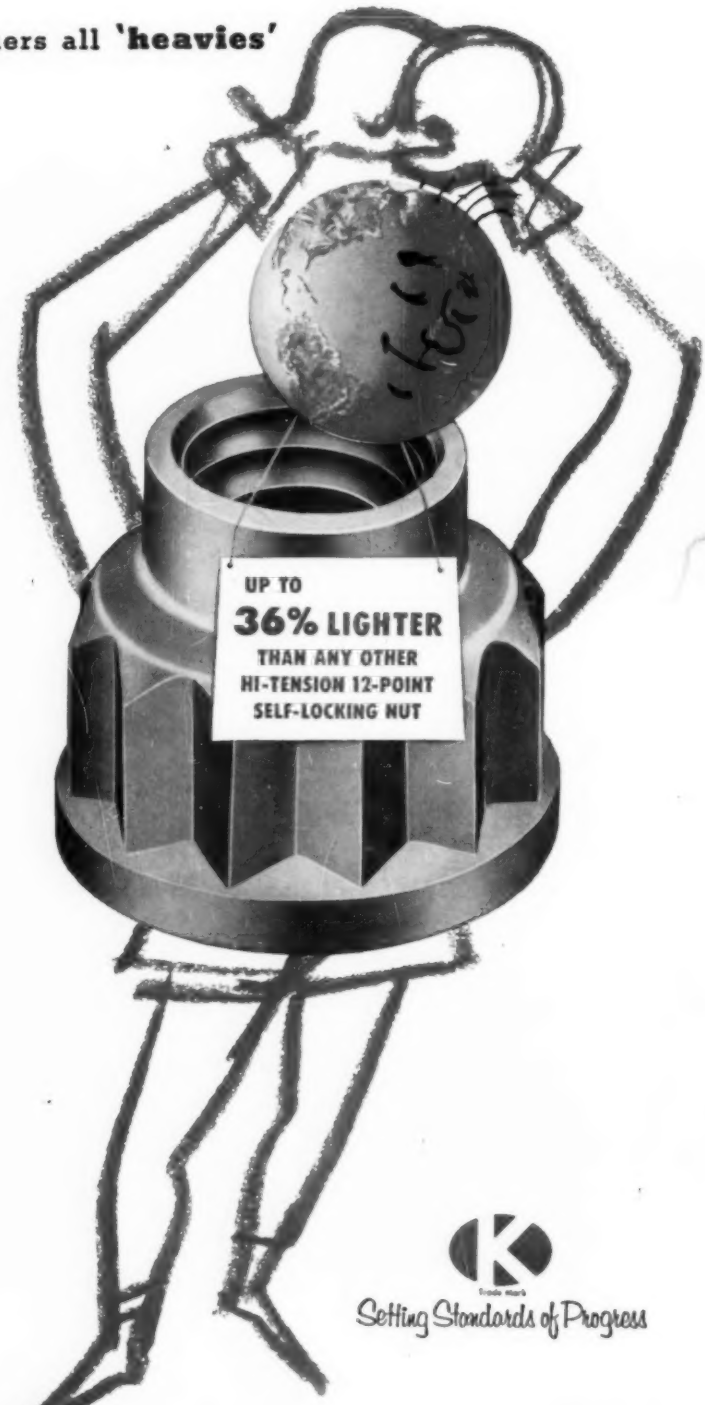
THE LIGHTWEIGHT CHAMPION OF THE WORLD!



Conquers all 'heavies'



It's no wonder that engineers think of the KAYLOCK H20 12-point nut as a "feather light titan." Up to 36% lighter than any other hi-tension 12-point self-locking nut, the H20 provides maximum structural properties of ultimate tensile strength and fatigue life. Kaylock's all-metal, self-locking, elliptical construction makes possible amazing savings in weight while actually increasing performance. Precision wrenching surfaces are designed to withstand full wrench torque requirements of 180,000 to 200,000 psi tension bolt applications (NAS624 series bolts).

Suitable for use in temperatures up to 550°F,– the KAYLOCK H20 offers complete load carrying threads throughout its height and combines a positive self-locking nut element with a permanent-type molybdenum disulfide lubricant. This combination provides for uniform pre-load in the bolted joint – to assure maximum fatigue resistance.

Tension fatigue tests and static tension tests conducted by both Kaynar and aircraft manufacturers, have established its rugged reliability.

Complete line of Kaylock all-metal self-locking nuts available in steel and A-286 corrosion-resistant steel.

KAYLOCK
All-metal self-locking nuts ®

conform to all Air Force - Navy standards: AN363, AN364, AN365, AN366, and the new low height National Aircraft Standards.

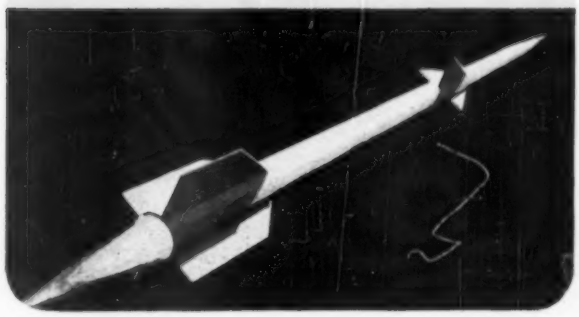
Setting Standards of Progress

Kaynar Mfg. Co., Inc. • Kaylock Division, Dept. LZ • Box 2001, Terminal Annex • Los Angeles 54, California • ©1957
Canadian Distributor: Abercorn Aero Ltd., Montreal, Quebec

SOLVING CHALLENGES IN SUPERSONICS:

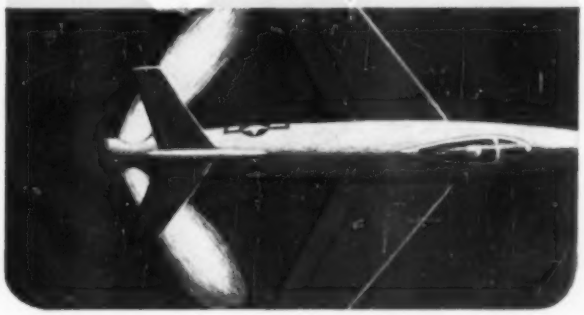
TO GUIDE:

UNERRING GUIDANCE heads a list of electronic achievements engineered by Goodyear Aircraft.

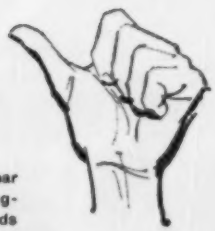


TO HALT:

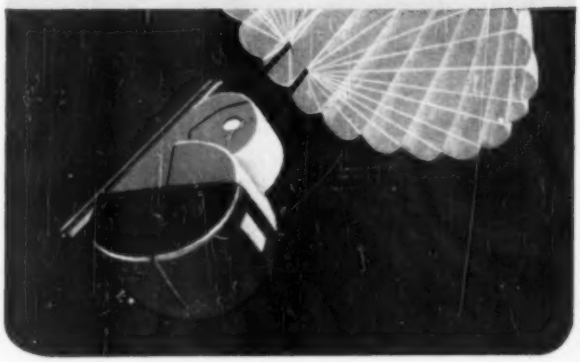
THRUST REVERSAL designed by Goodyear Aircraft makes shortfield capabilities a reality for high-speed jets — promising new margins of safety for carrier-based jet planes.



TO ESCAPE:



ESCAPE CAPSULE by Goodyear Aircraft—a down-to-earth, bring-'em-back-alive package — heralds fail-safe escape for any member of a jet crew.



TO FIND OUT:

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DEPARTMENT 931AM,
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WRITE TODAY for these and other answers to the challenges of supersonics engineered by Goodyear Aircraft.

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Plants in Akron, Ohio, and Litchfield Park, Arizona. Rewarding Careers for Engineers

Gulping 20 miles of sky per minute

Jets, vapor-trailing at twelve hundred miles plus per hour through the stratosphere, require precision-built rotors that compress air before injection into the burner cans. Ex-Cell-O builds both the rotors and blades for these fast-flying aircraft . . . along with fuel nozzles, actuators, valves, fuel controls, parts and assemblies.

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MAN AND MISSILES
FLY HIGHER, FASTER
AND SAFER WITH
PARTS AND ASSEMBLIES
BY EX-CELL-O

EX-CELL-O
CORPORATION
DETROIT 32, MICHIGAN

EX-CELL-O FOR PRECISION XLO
Aircraft Division

AVIATION CALENDAR

Jan. 6-8—Fourth National Symposium, Electronics Reliability and Quality Control, Hotel Statler, Washington, D. C.

Jan. 9-10—Meeting of Airlines Proximity Warning Indicator & Air Collision Avoidance System Committee, Hollywood-Roosevelt Hotel, Los Angeles, Calif.

Jan. 13-15—10th Annual National Convention, Helicopter Association of America, Western Hills Inn, Dallas-Ft. Worth.

Jan. 13-17—1958 Annual Meeting, Society of Automotive Engineers, Sheraton-Cadillac and Hotel Statler, Detroit, Mich.

Jan. 13-May 14—Lecture series on Space Technology, sponsored by University of California and Ramo-Wooldridge Corp., to be held in Los Angeles, San Diego and San Francisco. For details write: University of California Extension, Dept. of Conferences and Special Activities, Los Angeles 24, Calif.

Jan. 14-15—Yankee Instrument Fair & Symposium, sponsored by Instrument Society of America (Boston, Connecticut Valley and Fairfield County Sections), Hotel Bradford, Boston, Mass.

Jan. 18-31—14th Annual Technical Conference, Society of Plastics Engineers, Sheraton-Cadillac Hotel, Detroit, Mich.

Jan. 20—Winter Meeting, Provisional Western States Section The Combustion Institute, California Institute of Technology, Pasadena, Calif. For details write: Mr. G. S. Bahn, Marquardt Aircraft Co., Van Nuys, Calif.

Jan. 20—"Information Theory and the Communications Engineer," speaker Dr. Marcel Golay, consultant, Physical Sciences Auditorium, University of Pennsylvania, Philadelphia.

Jan. 20-21—First Annual General Meeting, Association of Local and Territorial Airlines, Washington Hotel, Washington, D. C.

Jan. 20-Feb. 7—Aviation Institute for Commercial Carriers and Business Pilots, Univ. of Southern California, Los Angeles.

Jan. 22-26—First International Air Show &

(Continued on page 6)

AVIATION WEEK • JANUARY 6, 1958

Vol. 68, No. 1

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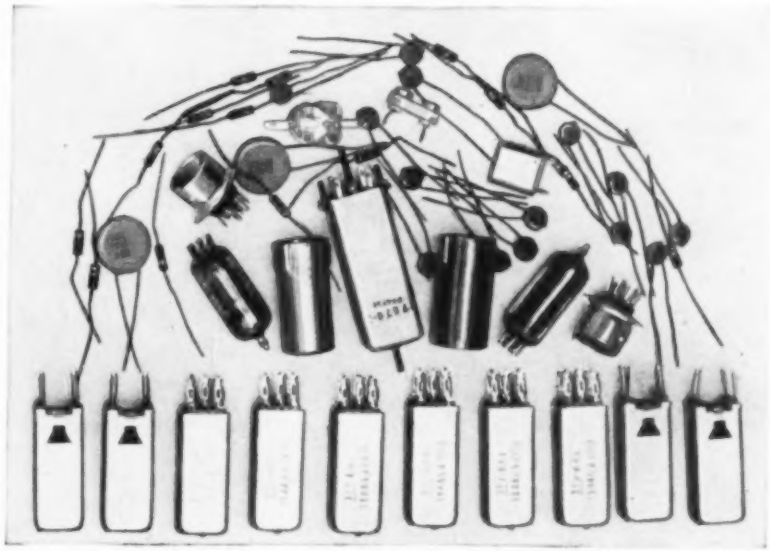
NOW YOU CAN REPLACE ALL OF THESE COMPONENTS



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WITH A SINGLE HYCON EASTERN CRYSTAL FILTER

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AND REDUCE WEIGHT, SAVE SPACE, IMPROVE PERFORMANCE AND RELIABILITY

It will pay you to investigate how this unique component can improve performance and reduce costs of your communications equipment. Hycon Crystal Filters make possible single conversions in AM and FM receivers while retaining the important advantages of double and triple conversions. These units permit excellent reception in the presence of strong jamming or interfering signals. Center frequencies are accurate to .001%. Insertion loss is 1/10 of other filtering methods. Aircraft and guided missile environmental requirements are exceeded. Write for Crystal Filter Bulletin.

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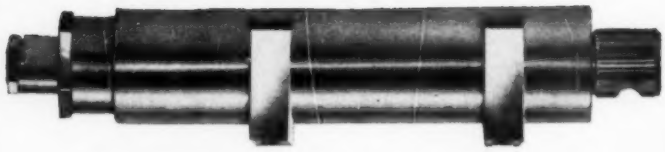
A FLUTTER DAMPER



DESIGNED BY

CLEMCO

AERO PRODUCTS, INC.

IS NOT JUST ANOTHER DAMPER

It MUST operate through minute amplitudes but be capable of moving through large amplitudes.
It MUST operate uniformly through extremely large temperature ranges.
It MUST dissipate energy at high frequencies which means that the dynamic spring* constant MUST be high.
It SHOULD be light in weight and of small envelope.

Through rigorous analysis CLEMCO has met the challenge of the aircraft and guided missile industry and now provides these industries with three basic damper sizes... EACH OF WHICH HAS THE GREATEST DYNAMIC SPRING CONSTANT, FOR ITS SIZE AND WEIGHT, EVER PRODUCED!

Outside Dia. (ins.)	Weight (lbs.)	Travel (deg.)	Damping Constant (in-lbs/rad/sec)	Dynamic Spring Const. (in-lbs/rad)
1.50	2.94	60	0-600**	163,000
1.75	3.81	70	0-750**	235,000
2.00	4.60	95	0-900**	300,000

CLEMCO Flutter Dampers have integral housing abutments which mean fewer assembly parts and extreme reliability.
CLEMCO Flutter Dampers are light weight, rugged, simple in construction, and held to the finest of instrument tolerances to provide a performance tested product...

*The spring which is a part of the damper and acts in series with the damping force.
**Max. setting for optimum in-phase damping at frequencies of from 35 to 50 CPS.

CLEMCO AERO PRODUCTS, INC. are furnishing the leaders of the aircraft and missile industry with the following:

ROTARY ACTUATORS
POWER STEERING UNITS
FLUTTER DAMPERS
MISSILE FINS AND SPARS
PROPRIETARY DESIGNS OF HYDRAULIC AND PNEUMATIC UNITS FOR MILITARY AND COMMERCIAL AIRCRAFT AND MISSILES

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AERO PRODUCTS, INC.

210 E. Manville St., Compton, California

This is #7 of a continuing series of advertisements prepared especially for the advancement of the aircraft industry by CLEMCO. Keep a file of them so you will have the complete story by CLEMCO.

AVIATION CALENDAR

(Continued from page 5)

Exposition, Master Field, Miami, Fla. For details write: P.O. Box 2879, Miami 17.

Jan. 27-30—26th Annual Meeting, Institute of the Aeronautical Sciences, Sheraton-Astor Hotel, N.Y.C. Honors Night Dinner, Jan. 29.

Jan. 28-31—14th Annual Technical Conference, Society of Plastics Engineers, Sheraton-Cadillac Hotel, Detroit, Mich.

Jan. 29-31—Fourth Annual Meeting, American Astronautical Society, Main Auditorium, Engineering Societies Bldg., 29 W. 39 St., N.Y.C.

Jan. 30-31—American Society for Engineering Education, 1958 College-Industry Conference, U. of Michigan, Ann Arbor.

Jan. 30-31—Seventh Annual Instrument Short Course, sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, at Los Angeles Harbor College, Wilmington, Calif.

Feb. 3-4—Industry-Service Symposium Flight Control-Panel Integration, Biltmore Hotel, Dayton, Ohio. For details: Mr. J. H. Kearns, Box 942, Dayton.

Feb. 19—"Are Flying Saucers Fact or Fancy?," Dr. Hugh Winn, Missile and Ordnance Systems Department, GE, Engineers Club, Philadelphia, Pa.

Mar. 13-14—Second National Conference on Aviation Education, Hotel Mayflower, Washington, D. C.

Mar. 17-20—Joint Aviation Conference, American Rocket Society-American Society of Mechanical Engineers, Statler-Hilton Hotel, Dallas, Tex.

Mar. 17-21—1958 Nuclear Congress, managed by American Institute of Chemical Engineers, 25 W. 45 St., N.Y.C.

Mar. 18-19—Conference on extremely high temperatures (over 30,000K), sponsored by USAF Cambridge Research Center, L. G. Hanscom Field, Bedford, Mass.

Mar. 18-19—First Interscience and Industry Symposium on Guided Missiles Training Equipment (limited to those with Secret clearance) Naval Ordnance Laboratory, White Oak, Silver Spring, Md. For details write: Mr. J. G. Vaeth, Head of New Weapons & Systems Division, U. S. Naval Training Device Center, Port Washington, L. I., N. Y.

Mar. 24-29—Fourth International Instrument Show, Caxton Hall, London.

Mar 30-Apr. 1—RFC-RNAS Reunion (World War I), Toronto, Canada. Contact: C. B. Stenning, Chairman, 149 South Drive, Toronto 5.

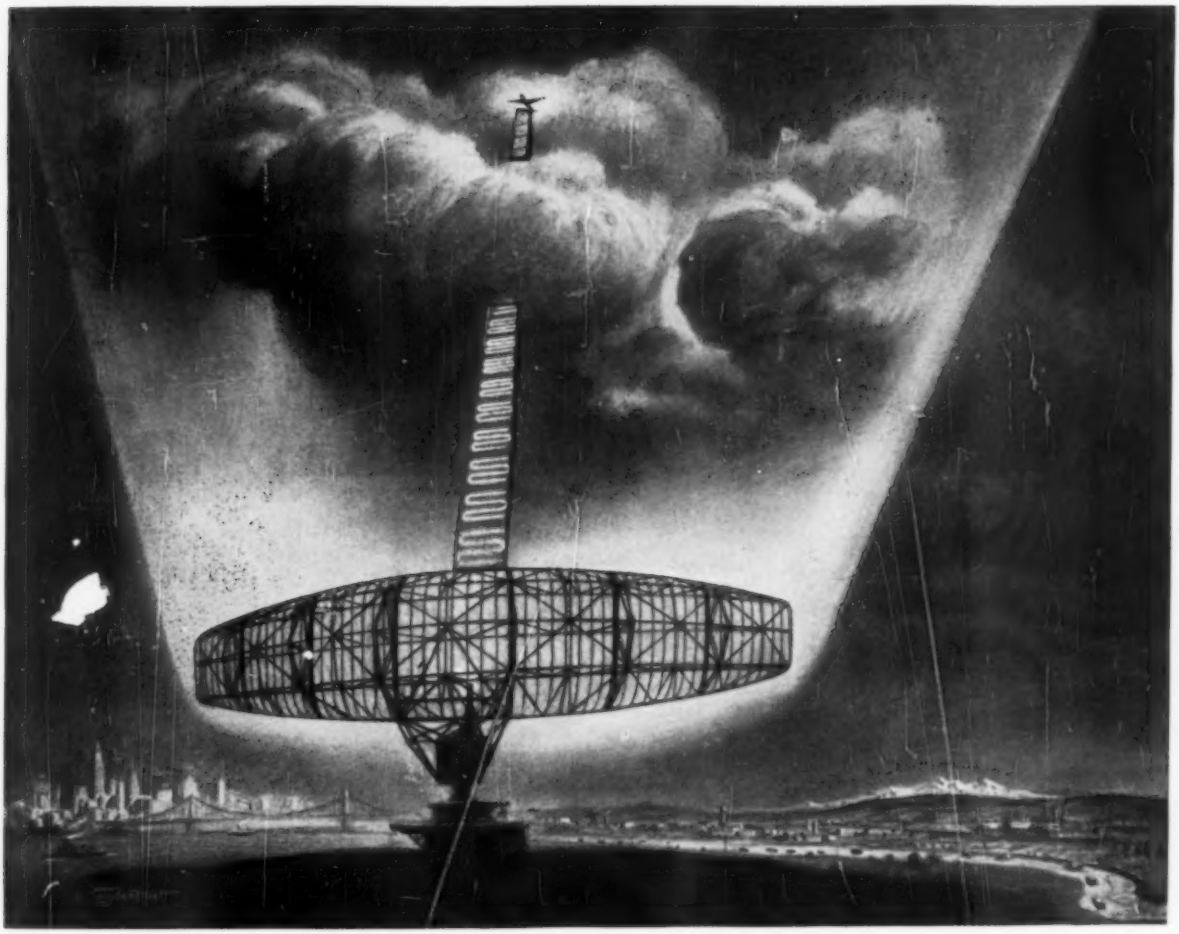
Apr. 8-10—Eighth International Symposia, Electronic Waveguides, Microwave Research Institute of Polytechnic Institute of Brooklyn Engineering Societies Bldg., 29 W. 39 St., N.Y.C.

Apr. 16-19—14th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York.

Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Sept. 1-7—1958 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.



C.A.A. buys 23 new Raytheon "Flight-Tracker" Radars

Long-range equipment to speed schedules, reduce "stacking" and air lane congestion; assure positive air traffic controls—create "more sky to fly in"

The Civil Aeronautics Administration has just taken a giant step to solve aviation's biggest problem: air traffic control.

New Raytheon radars with huge 40-foot antennas will be a key part of a complex nationwide air surveillance system that follows and helps safeguard all aircraft during every stage of flight. Radar scopes that display air lane maps pinpoint plane positions at distances up to 200 miles, altitudes to 70,000 feet.

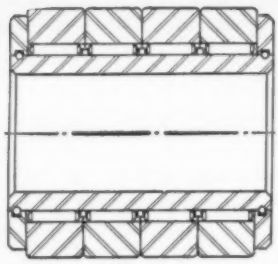
These "Flight-Tracker" radars detect and track aircraft in all kinds of weather—even see through storms. A unique indicator tells the operator when the unit needs servicing.

By making possible precise new air traffic patterns, by speeding arrivals and departures, Raytheon radar readies the air lanes for the Jet Age. Here is another instance where Raytheon's "Excellence in Electronics" clears a roadblock from America's path to air progress.

RAYTHEON MANUFACTURING COMPANY

Waltham 54, Massachusetts

RAYTHEON *Excellence in Electronics*



Special Cam Roller Needle Bearings designed for Hamilton Standard Division of United Aircraft Corporation have one-piece inner race, four rows of Needle Rollers separated by free-turning spacers, and four heavy-section outer races retained to inner race by snap-ring washers.

Special Torrington Bearing

smooths feathering of Hamilton Standard Reversible Propellers

Hamilton Standard's Reversible Hydromatic Propeller, standard equipment on a majority of transport aircraft, provides reversing of blade thrust for shorter, safer landings. It also enables the pilot to feather the propeller to stop or prevent windmilling on a malfunctioning engine.

Four special Torrington Cam Roller Needle Bearings help prevent hysteresis or "lag" in the cam-actuated feathering mechanism. Their full complement of needle rollers provides the highest possible radial load capacity with low breakaway torque, preventing surge in pitch change.

These special bearings are an adaptation of a standard cam roller aircraft type Needle Bearing, developed with the help of Torrington's extensive experience in design and application of Needle Bearings for aircraft. Take advantage of this engineering experience through your Torrington representative, or write: **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

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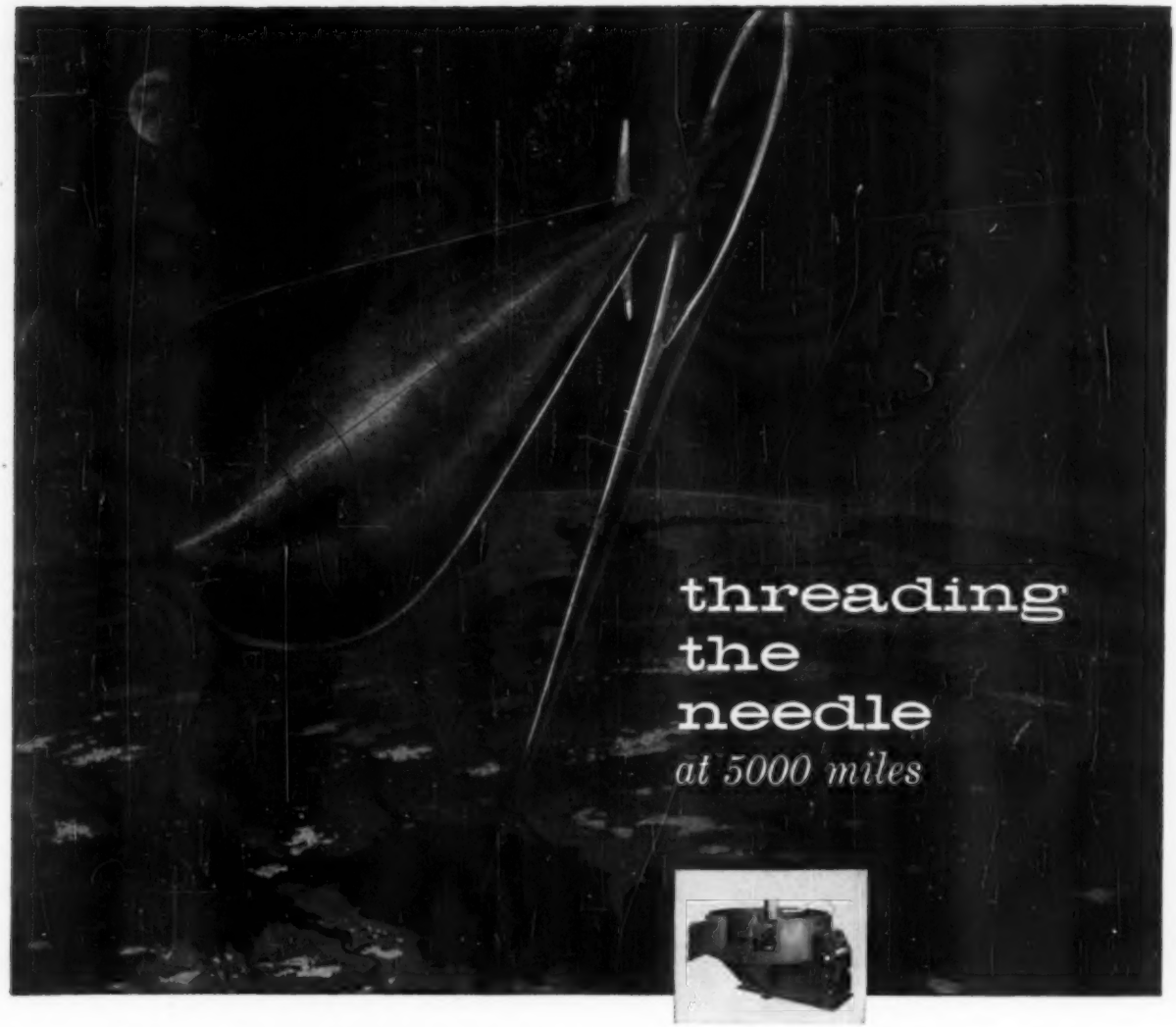

Genisco G-Accelerators play vital role in ICBM development

Threading the needle half-way round the world leaves no room for error.

Inertial guidance—self-contained guidance systems used to direct huge ICBM's to the target—depends for its accuracy upon the degree of internal instrumentation perfection. Switches, relays, delicate instruments, and hydraulic and electrical systems must operate perfectly—even while subjected to tremendous acceleration forces.

Testing components and complete asssemblies to simulated operational G-forces, as required by MIL-E-5272A, before relying upon their operation in actual flight is easily accomplished with Genisco's G-Accelerators.

Genisco's precision centrifuges are available in five standard sizes—from high-speed machines capable of high G-loadings, to large 12-foot diameter machines capable of accommodating complete electronic or electromechanical systems.

All models incorporate features necessary for critical laboratory testing, as well as the ruggedness and simplicity of operation required for production-line test programs.

Many automatic features minimize operator responsibility and chance for error. Built-in safety features and integrity of construction provide maximum protection to both personnel and machine.

Complete specifications on all machines and accessories are available. *Write, outlining your specific requirements.*

Genisco

reliability first

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MODEL BT8
Accommodates test objects up to 25 pounds; 1200 G-pounds max.

MODEL C150
Accommodates 100-pound test object on each end of boom; 2000 G-pounds max.

MODEL D184
Range of 1 to 800 G's; 1000 G-pounds max.

MODEL E185
Subjects two 300-pound assemblies to 100 G's. 30,000 G-pounds max.

ASTROLITE . . . a remarkable new high temperature material for Rocket and Missile insulation applications!

Out of HITCO's high temperature laboratories comes ASTROLITE... a **Refrasil-reinforced plastic** with impressive resistance to extremely high temperatures.

The excellent thermal shock characteristics and other outstanding physical properties of ASTROLITE make it an ideal insulation material to aid in Man's successful exploration of Space.

ASTROLITE is already proposed for use as liners for rocket engines and nozzles, nose cones for Intercontinental Ballistic Missiles and heat shields to protect critical components.

Complete technical data and dramatic proof of ASTROLITE's remarkable resistance to extremely high temperatures to 5000°F. **and higher**... is yours for the asking. Write to Director of Research.

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FREE NEW CHART!
Covers important points to consider in selecting high temperature insulation

REFRASIL BLANKETS | THERMO-COUSTI | THOMPSOglas | REINFORCED PLASTICS | HITCORE HONEYCOMB

WRITE OR CALL YOUR NEAREST HITCO REPRESENTATIVE: **EASTERN:** Tom Kimberly, 38 Crescent Circle, Cheshire, Conn., BRowning 2-6544 • **MIDWEST:** Burnie L. Weddle, 3219 West [illegible] Street, Indianapolis 22, Ind., WA 5-8685. • **SOUTHWEST:** Marshall Morris, 3515 Covert Avenue, Fort Worth, Texas, WA. 3-8098 • **NORTHWEST:** J. L. Larsen, 5757 Oakla[illegible] Ave., Seattle, Wash., MOhawk 9311 • **CANADIAN PLANT:** THE H. I. THOMPSON CO. OF CANADA LTD., 60 Johnston Street, Guelph Ontario, Telephone: TAylor 2-6630

for Delta's new Convair 880's...

Flight Control System—by Sperry

When Convair's new 880 jet airliners go into scheduled service for Delta Air Lines in 1960, they will be equipped with Sperry's new SP-30 electronic flight control system.

Developed especially for multi-jet and turbo-prop aircraft, the advanced SP-30 system provides smooth, accurate control over the full range of jet speeds and altitudes.

Passenger comfort and safety will reach new levels, with the SP-30 system supplying tight and fast-acting control of the 880 in all flight modes. And a companion compass system insures on-course navigation anywhere in the world, even over remote polar areas.

Equally important in Delta's view, the SP-30 features redundant circuits, transistors and magnetic amplifiers of "plug-in" design which spell maximum reliability and fast, easy maintenance.

SPENCER KELLOGG II, Assistant Chief Engineer of Aeronautical Equipment Division. A 20-year Sperry veteran, he has made important contributions in all phases of instrument and control engineering. He pilots both fixed-wing aircraft and helicopters.

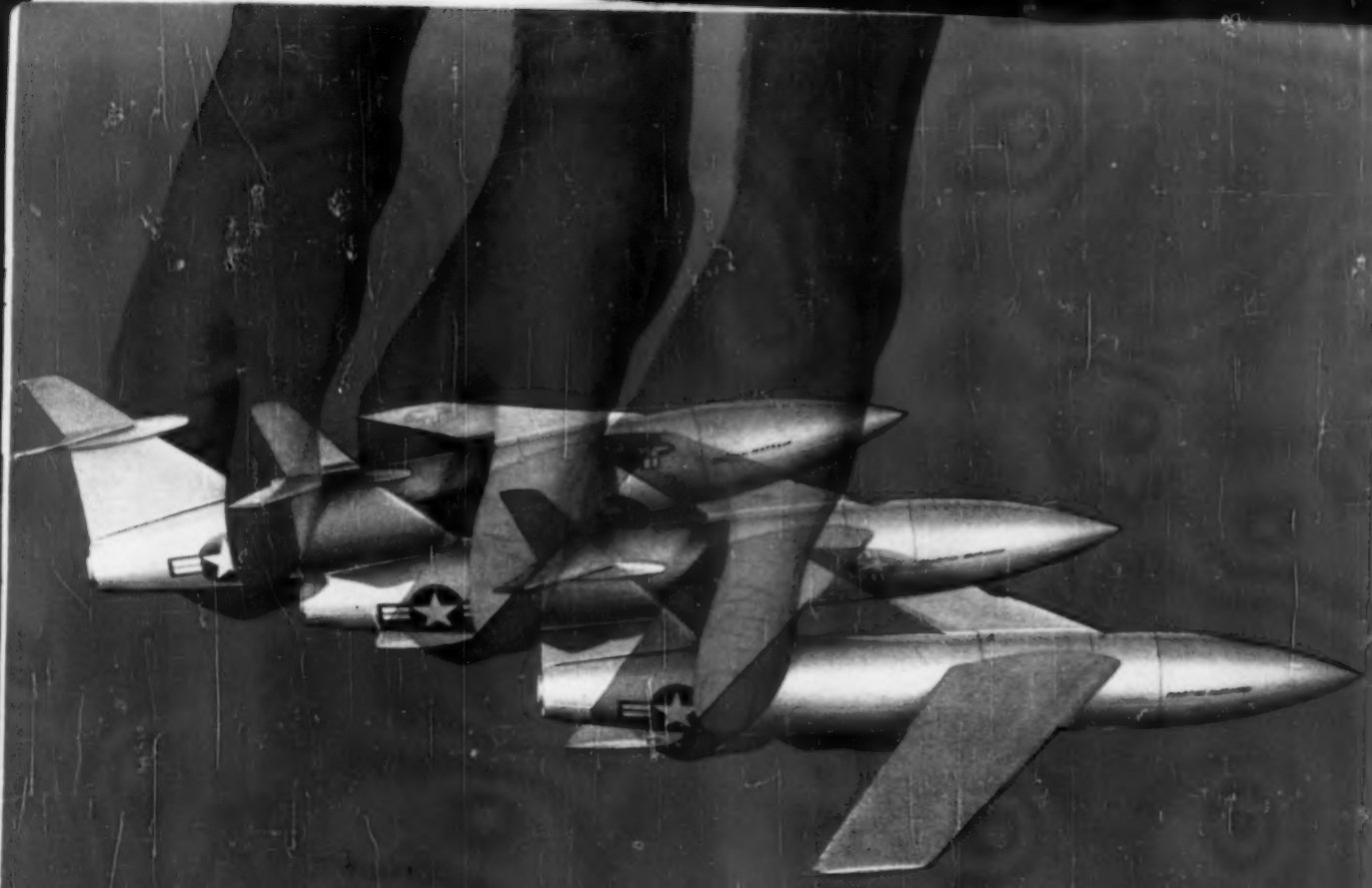
Today, Sperry continues as the nation's largest producer of automatic flight control systems for multi-jet aircraft. In addition, thousands of other Sperry systems are at work in aircraft of all types—from business planes and helicopters to attack bombers, transports and airships.

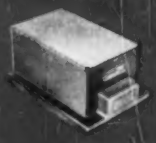
This record underlines once again the fact that when it comes to automatic flight control problems, Sperry engineers can meet the diversified demands of the industry. Write our Aeronautical Equipment Division for more information.

SPERRY GYROSCOPE COMPANY
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

BROOKLYN • CLEVELAND • NEW ORLEANS • LOS ANGELES • SAN FRANCISCO • SEATTLE. IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LTD., MONTREAL, QUEBEC





GUIDING HAND FOR THE MATADOR

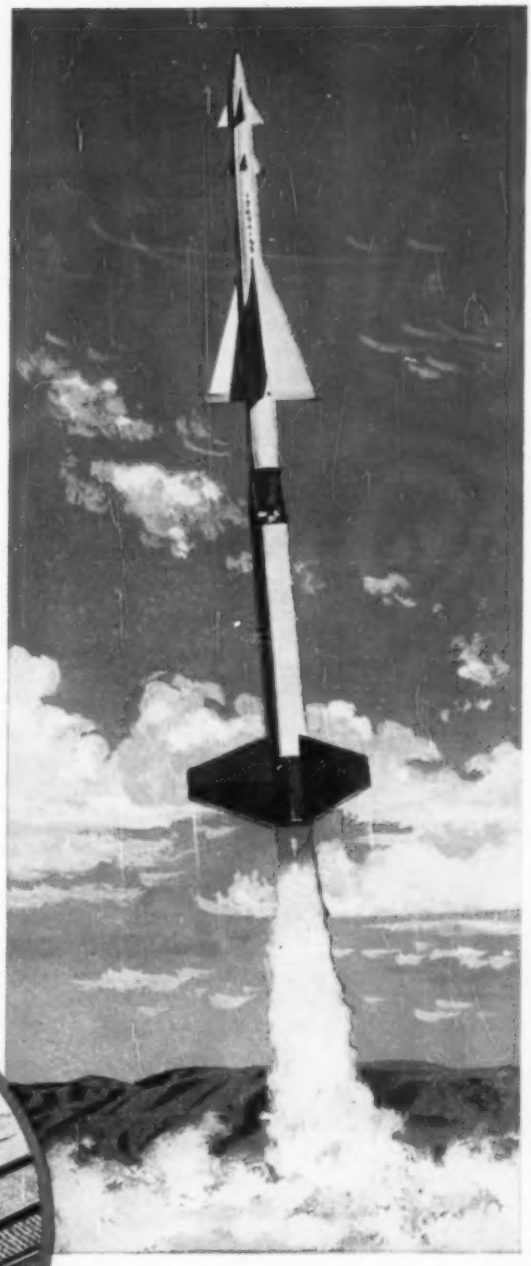
The Hallamore "Iron Autopilot" translates guidance signals into positive impulses that direct the Martin Matador, currently operational U.S. Air Force tactical missile, to its target. A solid state device, one sixth the size of vacuum tube units of equal capacity, it is proudly representative of Hallamore's many contributions to our Nation's defense, as well as to the general field of electronics.

HALLAMORE ELECTRONICS COMPANY *a division of the SIEGLER CORPORATION*

Engineers... Address Resume to Chief Engineer,
Hallamore Electronics Company | 8352 Brookhurst Avenue | Anaheim, California

53-43

On the Nike Ajax... the NARMTAPE® *goes along... Not just for the ride!*



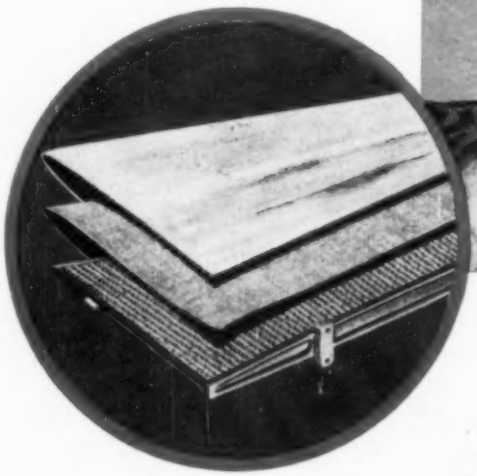
Missile engineers at Douglas Aircraft's Santa Monica Division chose bonded Aircomb* sandwich construction for the fins of the Nike Ajax because of Aircomb's superior strength-weight ratios, as well as its basic economy.

However, in selecting the proper adhesive for bonding the fins, several important factors were considered: First, the adhesive must retain its strength under anticipated air friction temperatures. Next, the adhesive must be impervious to temperature extremes, moisture and fungus... it was essential that the fins retain their designed load carrying qualities, no matter how, where, or for how long the missiles might be stored. Other important factors: ease of fabrication and uniformity of bonding.

Tests showed Narmtape® tops in every requirement. Narmtape's superior strength/temperature characteristics were more than adequate for the entire temperature range anticipated, and its moisture and fungus-resistant qualities were best in every way. Narmtape's even distribution of adhesive throughout the cotton supporting cloth was a distinct improvement over results attained by hand spraying, and was readily adaptable to volume production methods.

Narmtape is one of a family of outstanding adhesives developed by Narmco to achieve optimum performance in bonded sandwich structures. Facing a sandwich, laminate, or metal bonding problem? Let Narmco adhesives help point the way to an economical, performance-tested solution.

DOING JOBS
EVERY DAY
THAT METALS
ALONE
CAN'T DO!



NARMCO
PIONEERING THROUGH RESEARCH

Write today for specific performance and fabrication data on NARMCO ADHESIVES. Narmco technical field representatives throughout the United States and Canada can assist in solving your structural bonding design problems quickly, efficiently, economically.

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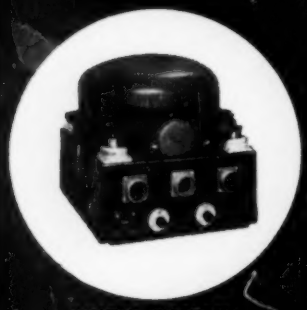
LOS ANGELES SEATTLE FORT WORTH DAYTON
TULSA PHILADELPHIA TORONTO

**Aircomb, a lightweight sandwich core material, is a proprietary product of Douglas Aircraft Co.*

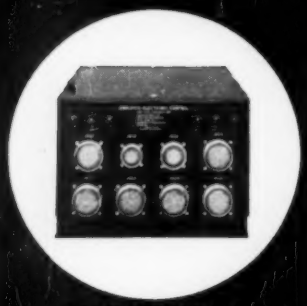
Status Report

KEARFOTT INERTIAL SYSTEMS

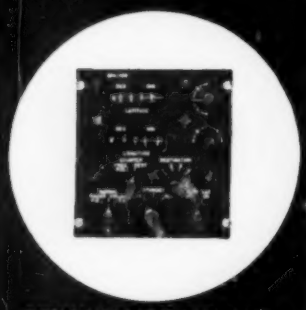
The unmatched precision of Kearfott's lightweight inertial systems has been proved by 4 years of exhaustive flight testing. These systems are in production.



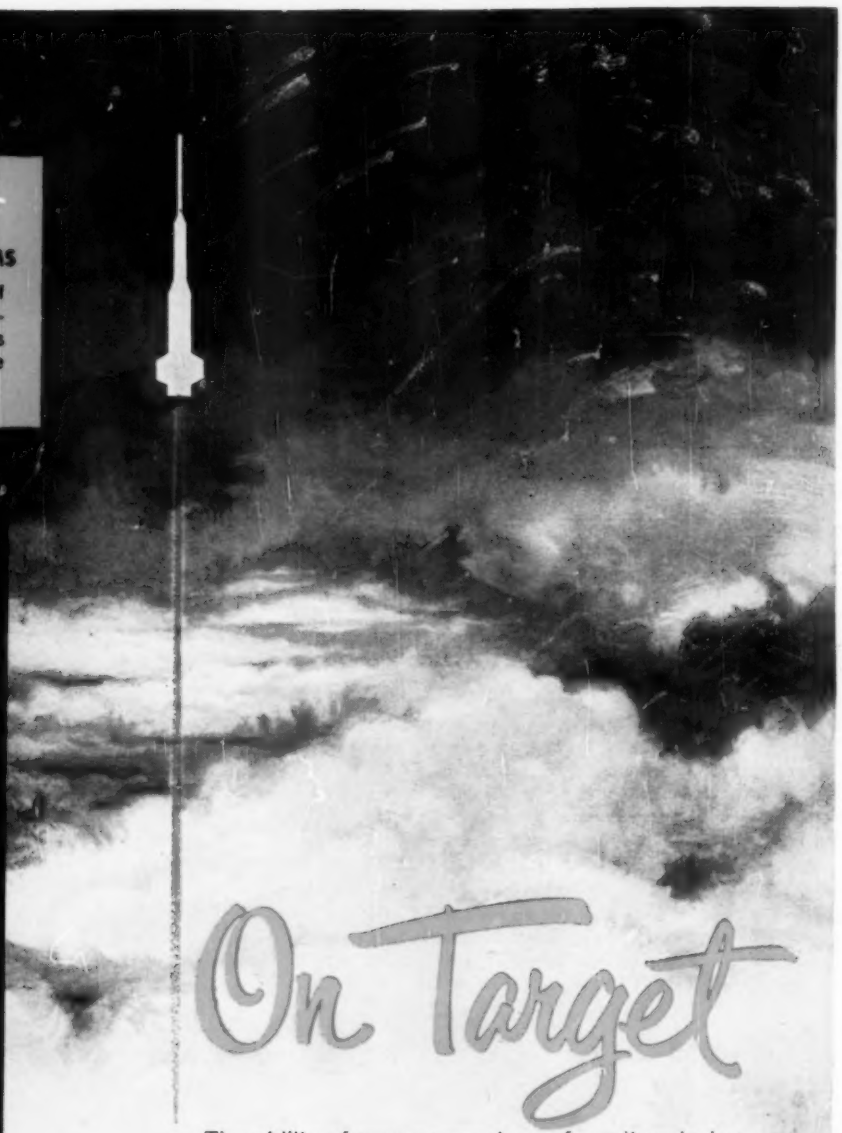
INERTIAL PLATFORM



COMPUTER-AMPLIFIER
ANALOG OR DIGITAL



DISPLAY AND CONTROL PANEL



On Target

The ability of any weapon to perform its mission is a function of the precision and reliability of its guidance system. Kearfott has been producing inertial components and systems for missile and aircraft applications for more than 7 years. You can look to Kearfott for the precision and reliability required in the design and production of this equipment.

Kearfott

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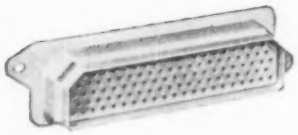
What's *new* for you in CANNON PLUGS



DPJ-33S

DPG-34P

- **Vibration**
- **Moisture**
- **Pressure**

▶ **PROTECTION**

with new DPJ and DPG Connectors

New DPJ and DPG Connectors feature sealing by means of a rubber seal around the insert faces. Exceptionally good protection against vibration and undesirable pressure and moisture conditions is provided. The DPG currently is available in 5 different insert arrangements, the DPJ with 3 insert layouts. **Write for Bulletin DP-101 TODAY!**

new

"EX" SEALED CONNECTORS

- **No Potting Required**
- **Light weight**

New EX Connectors feature a monobloc silicone insert into which the contacts are inserted after wiring. When the endbell is tightened over the insert, the contacts are completely sealed . . . giving a sealed connector of minimum weight without potting.

EX plug assemblies are currently available in four shell configurations with socket contact inserts . . . EX05, EX06, EXG06 and EX08. They are basically identical with the exception of endbell variations in each case. EX plugs mate and seal with standard AN, AN-E, and GS type receptacles, and are available in practically all AN layouts using #12 or #16 contacts from sizes 8S to 28. **Write for Bulletin PR-EX TODAY!**

new

Available in square-flanged receptacle, Q02, and straight plug, Q06. Insert Diameters: 31/64", 41/64", and 13/64"

"Q" MINIATURE CONNECTORS

- **Self-Locking**
- **Sealed**
- **Vibration Resistant**

Designed for control and instrumentation circuits of all types where space, vibration, moisture, or pressure conditions are limiting factors. Resilient grommets seal behind inserts . . . rubber sealing ring seals around the insert faces. Locking engagement accomplished by a beryllium copper latch within a spring loaded sleeve. Three shell sizes, with 7, 13, 19, 37 silver-plated brass 10-amp. contacts for #18 AWG wire. Alternate positioning. Cymel 592 insulators. External parts are cadmium plated aluminum. Hermetically-sealed, round-flanged receptacle, QH25, also available. **Write for Q Miniature Bulletin TODAY!**

CANNON PLUGS

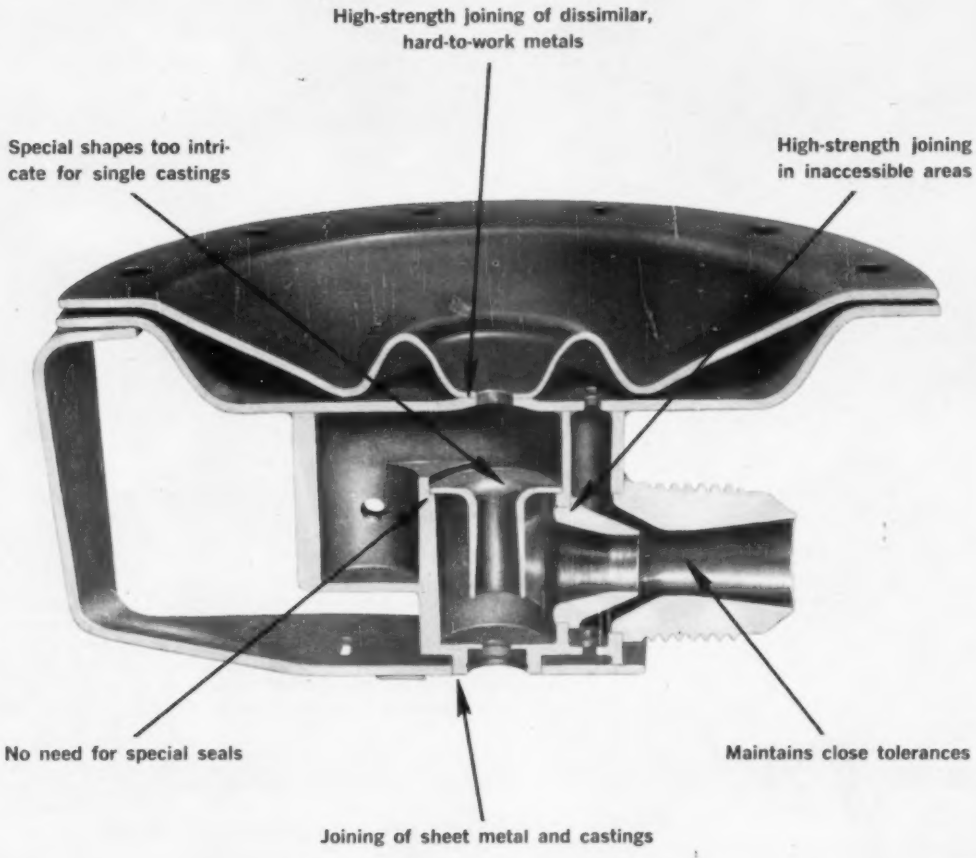
WHERE RELIABILITY IS THE 5TH DIMENSION

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, California.
Factories in Los Angeles, Salem, Mass., Toronto, London, Melbourne.
Manufacturing licensees in Paris, Tokyo. Representatives and distributors in all principal cities.

CANNON ELECTRIC

Please Refer to Dept. 110

Solar advanced brazing technology offers these advantages


High-strength joining of dissimilar, hard-to-work metals
Special shapes too intricate for single castings
High-strength joining in inaccessible areas
No need for special seals
Maintains close tolerances
Joining of sheet metal and castings

THIS INTRICATE CONTROL UNIT demands utmost precision—in design, manufacturing and assembly. That's why Solar engineers planned the entire unit for high-temperature brazing. This advanced joining method produces lighter, stronger, more compact components—faster, and at less cost.

Lightweight aircraft and missile components, for example, can be made to withstand higher temperatures than those at which they were brazed. And they can be made from dissimilar metals and high alloys that are *right* for high-temperature applications.

Effectiveness of this advanced assembly process has been proven by years of experience. If you would like to know how Solar can apply this design and brazing experience to your particular manufacturing problem, write to Dept. D-120, Solar Aircraft Company, San Diego 12, California.

SOLAR
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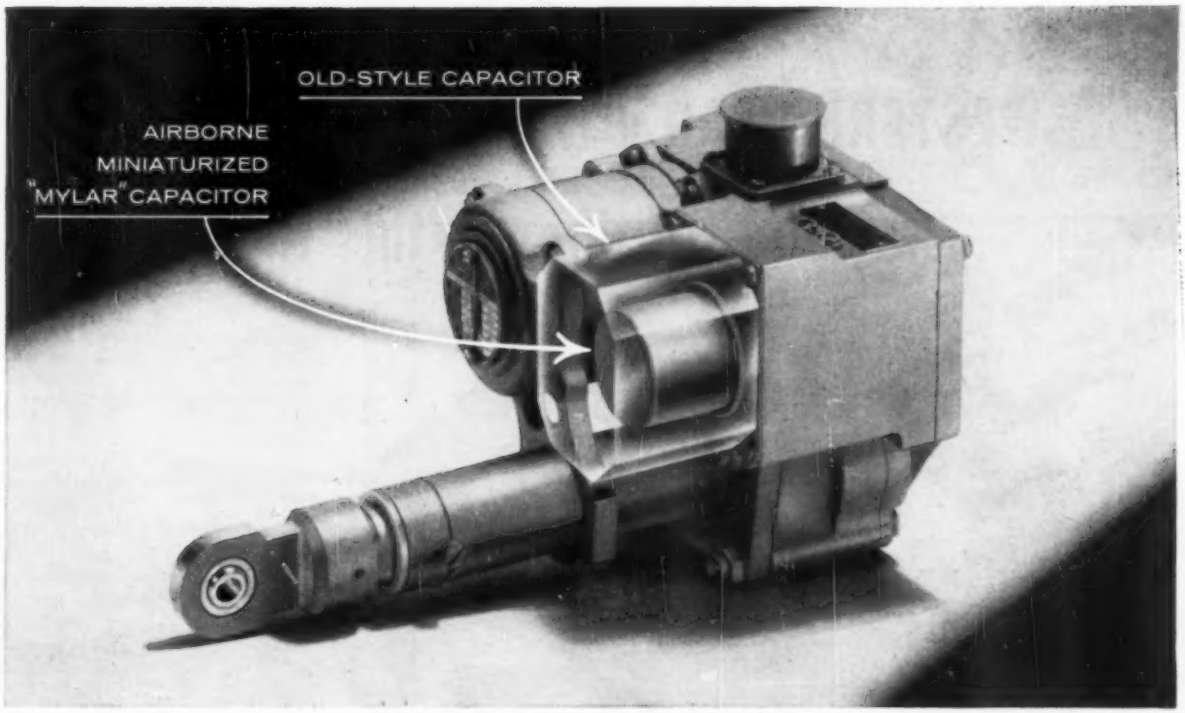
DES MOINES

DESIGNERS, DEVELOPERS AND MANUFACTURERS of gas turbines, expansion joints and aircraft engine, airframe and missile components.



Phantom view shows size of starting capacitor previously used on Model R-1514M1 Airborne Actuator. Change to Airborne-produced, miniaturized "Mylar" capacitor reduced weight of actuator 7.5 oz., increased motor starting torque 1.4 lb./in.

Airborne miniaturized Mylar* capacitor reduces actuator weight ½ lb., increases starting torque 78%

Airborne miniaturized capacitors with "Mylar" film can help you reduce the weight and bulk of many different electrically powered assemblies while actually improving their performance.

In the example above—in this case one of our own actuators—the use of an Airborne miniaturized capacitor cut actuator weight from 6 lb. 5.5 oz. to 5 lb. 14 oz. At the same time, capacitance was increased from 5 to 9.5 mfd and motor starting torque from 1.8 to 3.2 lb./in.

Wound of thin metallized "Mylar" film, Airborne miniaturized capacitors are invariably smaller and lighter than paper/foil capacitors or other common constructions. Yet they have capacitance ratings up to 12 times as high as ordinary capacitors of comparable size and weight. Dielectric strength is also greater because of the superior insulating qualities of "Mylar."

Airborne miniaturized capacitors are rated 200 v d-c and have an operating temperature range of −75°F to +300°F with only 12% capacitance change. At 300°F they will withstand 150% rated voltage for 250 hr. through a resistance of 1 ohm per volt.

Standard design capacitors meet specification MIL-C-25A and are available with three terminal options. Special design capacitors are made to your requirements and meet specifications JAN-C-25, MIL-1-6181B and MIL-M-8609.

Write, phone or wire for more information and quotations.

Airborne Standard Miniaturized "Mylar" Capacitors—200 v d-c

Microf. ±10%	Dia.	Length
.17	3/8	1-1/4
.5	1/2	1-1/4
1.0	5/8	1-1/4
3.0	7/8	1-1/8
4.0	1	1-1/8
5.0	1-5/32	1-1/8
6.0	1-1/4	1-1/8
7.0	1-5/16	1-1/8
8.0	1-29/64	1-1/8
9.0	1-1/2	1-1/8
.25	3/8	3/4
.4	1/2	3/4
.7	5/8	3/4
1.5	1	3/4
18.0	1-3/4	2-1/4

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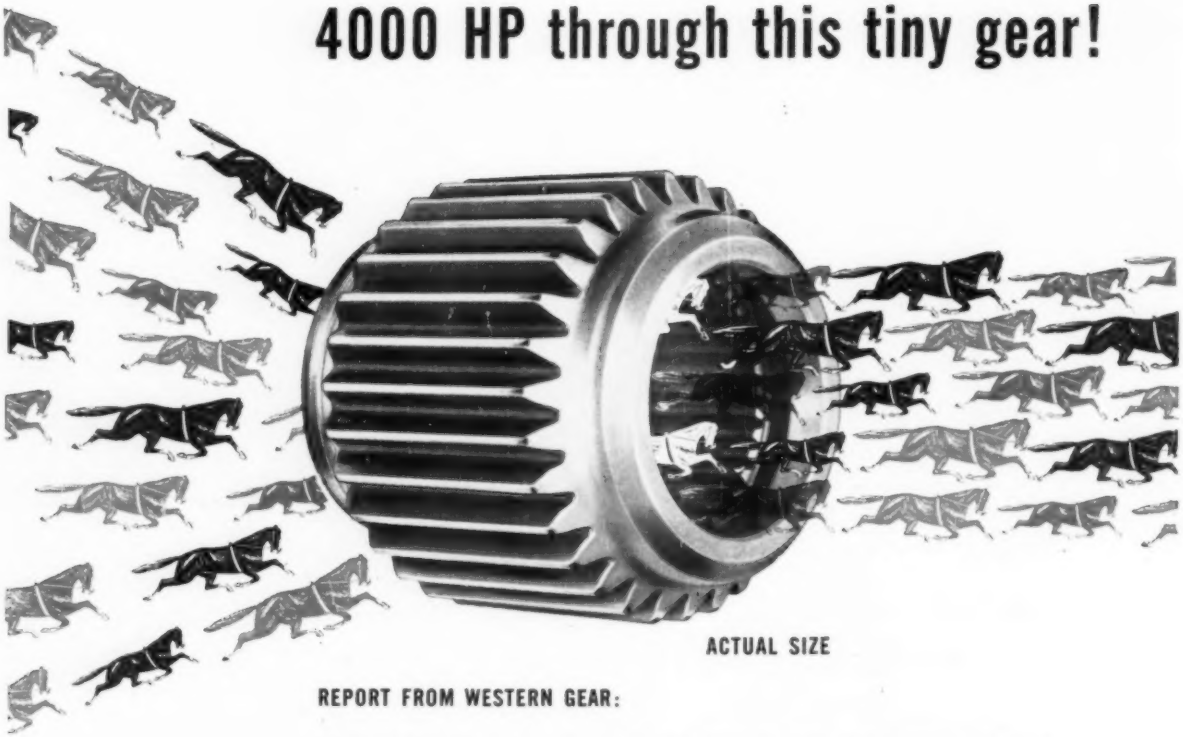
NEW CATALOG 57B

Gives detailed information on Airborne standard and special design miniaturized "Mylar" capacitors and Airborne R.F. filters. Write for copy.

WESTERN GEAR drives

4000 HP through this tiny gear!



ACTUAL SIZE

REPORT FROM WESTERN GEAR:

Western Gear engineers and production technicians have developed gears such as the one illustrated which, while less than 2-inches in size, will transmit 4000 HP with precision and dependability!

Let Western Gear's leadership in advanced research, metallurgical experience and precision manufacturing methods reduce your giant-size power transmission problems the same way... whether your requirements be for individual units or complete systems.

CALL YOUR WESTERN GEAR MAN
with any power transmission problems. Representatives in all principal cities. Or write in complete confidence and without obligation.

Glenn Malme • WESTERN GEAR CORPORATION P.O. Box 182, Lynwood, California

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January 6, 1958

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French Triple Helicopter Strength in War 26
▶ Air Force, Army and Navy now have sizable helicopter units on combat duty in Algeria and buildup isn't over yet.

New Period of Uncertainty Faces TWA 40
▶ Burgess resignation leaves TWA in same leaderless state that followed death of Ralph Damon in 1956.

Ford Speeds Space Research 51
▶ Company funds are being used for studies in such fields as impacting on the Moon.

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More Jet Helicopters 21

COVER: French Air Force H-34 drops to a pickup point to take on commandos in the Sahara area, Algeria. Bull's eye insignia have been obliterated, since the French found they served as targets for rebel small arms fire. Air Force today has 44 H-34s and a total of 99 helicopters, compared to 10 H-34s and a total of 41 helicopters a year ago. For Part I of a report about France's intensified military helicopter operations in Algeria, see p. 26.

70,363 copies of this issue printed

AVIATION WEEK • January 6, 1958 • Vol. 68, No. 1

Member ABP and ABC

Dow high temperature magnesium alloys have excellent fabrication characteristics

Lightweight structural metals with high strength, stiffness and elasticity at elevated temperatures! A new group of Dow magnesium alloys offers a great combination of these properties without the fabricating difficulties normally experienced with other high temperature materials.

Specially developed for use in airframes, missile and engine structures, the new alloys are already making weight reductions possible for several manufacturers. These alloys show advantages at temperatures up to 700°F. Limited test data on properties up to 800°F. are available for some of them.

FABRICATION: Fabrication characteristics are equal to those of standard magnesium alloys.

WELDABILITY: 95 to 100% weld efficiency at elevated temperatures.

FORMABILITY: Single deep draws can be easily accomplished.

MACHINABILITY: Best machining characteristics of any structural metal.

One of the new alloys is magnesium-thorium composition HK31A. It is now available in rolled form from stock. Castings and sheet in mill quantities are also readily available. A companion alloy for extruded shapes and forgings will soon be in production.

For more information about the new high temperature magnesium alloys, contact your nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Magnesium Sales Department MA 362G, Midland, Michigan.

EASILY FORMED. These HK31A parts were drawn using production dies and processes for standard magnesium alloys. The parts retained a higher percentage of original properties than standard alloys.

YOU CAN DEPEND ON DOW

EDITORIAL

Hope of the Nation

On the last afternoon of 1957 most of our Washington staff were sitting around the large bullpen that is the main area of AVIATION WEEK's offices in the National Press Building. We were ruminating on some of the sour news of the fast-fading year, particularly the mass of technical misinformation deliberately foisted on the unsuspecting American public by many highly placed government officials.

Into this somewhat dour gathering popped a young man armed with a shiny half dollar asking to buy the latest issue of AVIATION WEEK. Since the "need to know" is an element of contemporary American technical life, we interrogated this young man on his requirement for the type of technical material contained in our magazine and informed him the price had risen some months before to 75 cents per copy. The young man informed us his first name was Langford, his age just past 11 and offered us a sporting proposition. "Show me the silhouette of any airplane and I'll tell you what it is and who makes it," he challenged.

We rummaged in our files and picked a silhouette of one of the latest Russian delta fighters designed by Pavel Sukhoi and code named Fishpot by NATO. Langford promptly identified it by its NATO code name and credited it correctly to Tovarich Sukhoi. This piqued our curiosity sufficiently to continue the quiz on contemporary technical matters to find out just how hep an 11-year-old afficionado could be. Frankly we were astonished at both the accurate technical detail and political savvy demonstrated by 11-year-old Langford. He had an accurate rundown on the WS-110A chemically fueled bomber project for which a contract was recently awarded to North American Aviation, Inc. But he was curious as to why Boeing, with its long record in heavy bomber production, didn't get the contract and wanted to check some details on just how the chemical fuel was actually used in a turbojet engine. Langford was a little disgusted at the slow progress on the WS-125A and when we asked him if he had any opinions as to why it was lagging he answered:

"They're just not putting any money into it."

We turned to the political and administrative aspects of the situation and our military editor asked Langford:

"Do you think Mr. Holaday is doing a good job as missile czar in the Pentagon?"

"Naaaah!" was Langford's disdainful reply, adding "but this guy McElroy sounds like he can do a good job." Langford then gave us a rundown on some other recent Pentagon civilians in which it developed that the former Secretary of Defense Charles E. Wilson fell into the same category as Mr. Holaday and concluded with a dissertation on the ethics involved in the late Harold Talbott's affiliation with a management consulting firm while he was Secretary of the Air Force.

Langford told us that during school vacations he generally gets on a bus and comes downtown to "find out what's going on" and that he intends to be an aeronautical engineer and study at the Massachusetts Institute of Technology. Needless to say, Langford got his copy of AVIATION WEEK without parting with his half dollar. He departed leaving a group of somewhat tired editors buoyed with new hope that with people like Langford coming along the future of this nation doesn't look quite as dark as it did before he came in to buy his magazine.

More Jet Helicopters

In our Dec. 30 editorial passing out laurels for aviation achievements during 1957 we cited Bell Helicopter Corp., Vertol Aircraft Corp. and the Sikorsky Division of United Aircraft Corp. "for bringing gas turbine powered helicopters to the flight test stage and opening the era of that machine's greatest utility." This comment promptly drew a telegram from Charles Kirchner, vice presidential press agent for Kaman Aircraft Corp., of Bloomfield, Conn., asking why his firm was not included in this citation and listing the achievements of his firm in this area.

Kaman Aircraft Corp. has certainly enjoyed a remarkable growth since the days when Charley Kaman, its president and founder, left the Hamilton Standard Division of United Aircraft Corp. to set up shop in a wooden hangar at Bradley Field to develop his co-axial rotor design. The firm is now housed in about 500,000 sq. ft. of three plants, including a $4 million modern facility financed by the Navy at Bloomfield.

Kaman flew the first turbine powered helicopter in the world in 1951 using an HTK with a Boeing 502 free turbine jet powerplant. Its HOK powered by a Lycoming T53 gas turbine made its first flight in September, 1956, and was in flight test during 1957. Kaman also flew a twin Boeing powered HTK in 1954 and now has two production contracts for new gas turbine powered helicopters. One is the Navy's HU2K-1 utility helicopter and the other is the Air Force H-43B crash-rescue helicopter. To Charley Kaman, his engineers, salesmen and production workers a belated but sincere sprig of AVIATION WEEK 1957 laurels.

—Robert Hotz

NEW LIQUID NITROGEN PUMP PROVIDES HIGH PRESSURE GAS FOR MISSILES AND ROCKETS

It solves many missile systems problems and is highly useful for aircraft cooling systems and ground support equipment

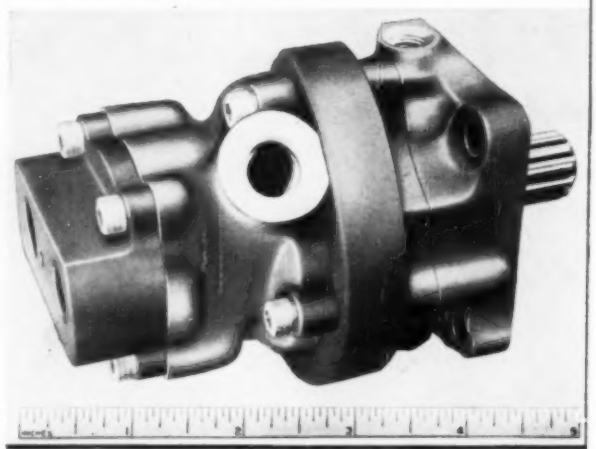
A compact, extremely light weight unit, it can be used to supply high pressure nitrogen gas in almost unlimited applications. A positive displacement type liquid nitrogen pump, it is driven by a small turbine and is installed in a vacuum jacketed liquid nitrogen container which serves as a supply reservoir. By passing the liquid nitrogen through a heat exchanger, it is converted to a gas at 3000 psi which serves to drive the turbine and pump as well as furnish a gas supply for missiles, aircraft or other uses.

Experimental development and testing over a period of a year have demonstrated its capability and engineering studies show that the unit is a means for solving the following problems:

1. Pressurization of propellant tanks.
2. Purging of fuel tanks.
3. Cooling of electronic equipment.
4. Local cooling of aerodynamic surfaces.
5. Provision of clean inert pneumatic system working fluid.
6. Provision of clean inert working fluid for accessory power unit.
7. Provision of fire extinguisher fluid.
8. Provision of ground supply of high pressure nitrogen.

By combining several of these functions in one system, substantial weight savings can be made by elimination of duplicate equipment.

For complete performance data or further information on how this unit may be used to solve your problems, please contact our Application Engineering Department.



SCHEMATIC DRAWING OF LIQUID NITROGEN PUMPING UNIT

SUNDSTRAND

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A DIVISION OF SUNDSTRAND MACHINE TOOL COMPANY

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WHO'S WHERE

In the Front Office

Thomas S. Banes, director of the Air Navigation Bureau and Assistant Secretary General, International Civil Aviation Organization, Montreal, Canada.

Dr. B. D. Thomas succeeds **Dr. Clyde Williams** as president, Battelle Memorial Institute, Columbus, Ohio.

Russell W. McFall, a vice president, Litton Industries, Beverly Hills, Calif., and general manager of the Maryland Division. Mr. McFall succeeds **Dr. Harvard L. Hull** now president of Nucledyne Corp., subsidiary of Cook Electric Co., Chicago, Ill.

Honors and Elections

Winston Castleberry, vice president of Southwest Airmotive Co., has been elected president of the Aircraft Service Association, Los Angeles, Calif. Mr. Castleberry succeeds **Douglass F. Johnson,** president of Aircraft Engineering and Maintenance Co.

Dr. Ernst Weber has been elected president of the Polytechnic Institute of Brooklyn, succeeding **Dr. Harry S. Rogers,** deceased.

J. G. Nettleton, Jr., vice president of Northrop International, Northrop Aircraft, Inc., has been elected 1958 chairman of the Export Committee of the Aircraft Industries Association, Inc., Washington, D. C.; **George S. Wheat, Jr.,** of Republic Aviation Corp., has been elected vice chairman.

Peter Duyan, Jr., chief electrical engineer of Douglas Aircraft Co., has been elected president of the Aircraft Electrical Society, Los Angeles, Calif., and **A. A. Waldron** of Lockheed Aircraft Corp., has been elected vice president.

Changes

Lucius W. Burton, director of Washington National Airport, succeeding **Bennett H. Griffin,** retiring.

Bernard L. Goldwasser, supervisor of process engineering, Printed Circuit Dept., Packard-Bell Electronics Corp., Los Angeles, Calif.

Donald C. McDonald, director-product engineering, Cook Electric Co., Chicago, Ill.

Stuart R. Hennies, manager-applications engineering, Granger Associates, Palo Alto, Calif.

John M. Lester, engineering manager, and **Robert C. Lyons,** sales manager, newly created Countermeasures organization, Sperry Gyroscope Co., division of Sperry Rand Corp., Great Neck, N. Y.

William W. Harger, chief project manager, Link Aviation, Inc., Binghamton, N. Y.

Dr. Ernst Steinhoff, associate technical director, Aerophysics Development Corp., Santa Barbara, Calif.

J. T. Cosby, manager, and **G. S. Green,** assistant manager, Customer Service Dept., Convair, division of General Dynamics Corp., Fort Worth, Tex. Mr. Cosby also continues as B-58 program director.

Bonham M. Fox, director-passenger sales, American Airlines, Inc.

INDUSTRY OBSERVER

► New and unique method for passive monitoring of Russian missile firings from sites in this country will be studied for the Office of the Assistant Secretary of Defense for Research and Engineering by Stavid Engineering Inc., Plainfield, N. J. Technique is considered sufficiently promising that Defense has ordered that information not be made available to even military authorities except by direction of the Assistant Secretary's office. Stavid has been directed not to make further proposals to the military services in an effort to keep the method under wraps.

► **First test flight of Martin-USAF's Titan intercontinental ballistic missile is scheduled for October.**

► During recent weapon delivery flight test, Lockheed F-104A ranged out more than 600 mi., delivered its weapon in the supersonic flight regime and returned to its base with more than 500 lb. of fuel remaining after the flight's completion.

► **North American Aviation Inc. plans to extend the runway at its Columbus Division by approximately 2,000 ft.—to 10,000 ft. plus—to make the field suitable for flight testing the company's supersonic A3J-1 attack-bomber. Navy will pay for the extension while North American is responsible for making the necessary arrangements such as property purchases, etc.**

► The Martin Co.'s Denver Division has awarded Flight Refueling Inc., of Baltimore, a contract for engineering-consulting services on fuel handling in development of USAF's Titan intercontinental ballistic missile. Flight Refueling personnel with engineering experience in fluid transfer and complementary structural fields will be available to Martin prior to the first test firing of Titan.

► **Several firms have submitted proposals to Navy's Bureau of Ordnance for underwater-launched ballistic missiles as anti-submarine weapons.**

► Latest configuration of de Havilland-Canada's twin-engine Caribou transport-utility aircraft has a single tail replacing a dual layout planned earlier (AW April 1, p. 33). Overall height is now 36 ft. instead of original 27 ft., nine inches. Fuselage of first prototype has moved out of its jig, second is now being fabricated. Company hopes to fly the first Caribou in June or shortly thereafter. In addition to military orders, the firm will seek Caribou sales in the U. S. Southwest among feederlines as a "DC-3 replacement." Estimated price for Caribou will be in the $400,000-$500,000 range. Direct operating costs will be similar to the DC-3, but seat-mile and ton-mile costs are expected to be better. De Havilland-Canada has military contracts for five Caribous from the U. S. Army, two from the Canadian government.

► **Russian sources indicate that practical altitude limit for ramjet operation is 130,000 to 160,000 ft., somewhat higher than normally considered possible in U. S.**

► Soviet boost-glide bomber probably will be towed to 80,000-100,000 ft. by a ramjet-powered tug. Ramjet also may be used as the second stage of a four-stage spaceship launching vehicle. Other stages will consist of liquid rockets.

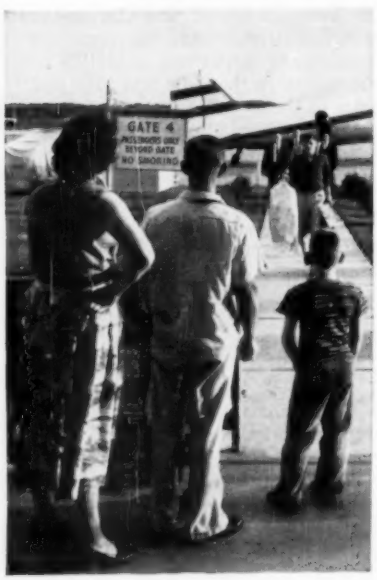
► **Small-scale version of Bendix's "time-of-flight" mass spectrometer is being readied at the Air Force's Cambridge Laboratories for installation in a rocket. Project was stimulated by Sputnik I's recent and unexpected loss of altitude, indicating that previous knowledge of atmospheric density and content were faulty. The Bendix instrument is capable of up to 21,000 separate analyses a second, and data could be radioed back to earth. Details on the conventional unit were reported by Aviation Week on Dec. 21 (page 61).**

► First Convair B-58 supersonic bomber will be turned over to Air Force this month for performance and stability tests. Aircraft will be delivered to Edwards AFB, Calif.

Bringing the JET AGE to Main Street, U.S.A.

The Jet Air Age is coming to Main Street, U.S.A., on the wings of the first American-made short to medium-range propjet liner—the Fairchild F-27. With deliveries to local and regional airlines only a few months away, this modern, pressurized transport will be serving scores of small and middle-sized communities two years before the big transcontinental jets begin to touch down at major metropolitan areas. Such place names as Apple Valley... Chehalis... Larkston...Red Bluff...Hickory...Brady ...Tonopah...Wolf Point...Berger... Marion...Bemidji...Logansport...Keene ...Bellafonte...Bluefield...Gadsden... typify the smaller cities and towns the Fairchild F-27 will soon put on the Jet Age air map of Main Street, U.S.A.

These communities for ten years have been increasingly important stops on routes flown by the nation's dynamic and progressive local airlines...the local airlines which have linked Main Street, U.S.A., into the nation's vast network of air routes, bringing millions of men and women closer to their neighbors, to metropolitan centers, to foreign lands and peoples.



But local airlines have done and are doing more than to carry the banker, the businessman, the mining engineer, the vacationer, the farmer, the housewife to their destinations. Local airlines also help to stimulate commerce. They speed economic growth of community and region. They facilitate decentralization of industry. And they carry mountains of mail and an ever increasing volume of air freight.

From a faltering beginning in 1946 as airlines authorized to supplement the passenger, freight and mail services of the big "trunk" lines, the nation's local carriers have become indispensable in their particular areas. Indispensable as links among smaller cities and towns, indispensable in the traffic generated to major metropolitan areas.

Public reaction to the new air service, the first in the history of many towns, villages and small cities, was highly gratifying. And that acceptance has grown in the past decade into a strong feeling of pride in "our" airline. And this confidence of the air traveler on Main Street, U.S.A., in his local airline—demonstrated by his steadily increasing use of its facilities—has spurred each line to gear its operations to meet the changing needs of air travelers in communities it serves. The emphasis is on service.

Now the local airlines are on the threshold of a new era of service to the more than 500 communities at which they touch down every day. This bright, new era is dawning because the first modern aircraft designed for their type of specialized services is now available.

It is the Fairchild F-27, a propjet, 40-passenger transport that will, within a few months, bring the nation's small communities into the Jet Air Age by providing greater speed—more than 100 m.p.h. faster than present aircraft—and by adding such comfort features as pressurization and air-conditioning. They will bring to Main Street, U.S.A., too, air travel almost completely free of vibration and air travel in which cabin noise level will be remarkably low.

The F-27's arrival in the months ahead at Casper, Ada, High Point and hundreds of other air-conscious towns from coast to coast and border to border does, indeed, herald the advent of the Jet Air Age for Main Street, U.S.A.

The F-27 is in production at the Fairchild Aircraft Division, Hagerstown 10, Md.

Airlines soon to fly the Fairchild F-27

AREA (Ecuador)
Avensa (Venezuela)
Bonanza Air Lines (U.S.)
Linea Aeropostal Venezolana, LAV (Venezuela)
Mackey Airlines (U.S.)
Northern Consolidated Airlines (Alaska)
Piedmont Airlines (U.S.)
Quebecair (Canada)
Southwest Airways (U.S.)
West Coast Airlines (U.S.)
Wheeler Airlines (Canada)
Wien Alaska Airlines (Alaska)

Fifteen leading corporations also have ordered the F-27.

...WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS!

FAIRCHILD
ENGINE AND AIRPLANE CORPORATION
HAGERSTOWN 15, MARYLAND

Washington Roundup

Grim Assessment

Grim assessment of the government's failure to grasp the significance of the world military situation came last week from Dr. Isador I. Rabi, who is chairman of the President's Science Advisory Committee and was an advisor to the committee that prepared the Gaither Report on U.S. preparedness (AW Dec. 2, p. 28).

Rabi said the U.S. and the world are confronted by "the severest problem that civilized humanity has had to face at any time," but the facts of modern weapons "have just not penetrated" at top levels of government.

Rabi spoke extemporaneously for 45 minutes to a Columbia University alumni meeting. At the end of his talk he said: "Well, I'm glad I got it off my chest." Recalling former Secretary of Defense Charles E. Wilson's deprecation of the importance of the first Soviet satellite, Rabi said: "You can see why I am so pleased that he is not there anymore."

The public has shown very good sense by being alarmed, Rabi said. "Attempts to calm us down are no good. We must take immediate thought to what we shall do."

Education Spur

A billion dollar, four-year federal program to spur education, particularly in the sciences, will be presented to Congress in the President's budget message this week.

Administration insists the plan has been in the works for two years, is not a post-Sputnik creation but concedes that "education is now more crucially important to long term national security than ever before.

Program includes 10,000 college scholarships a year for deserving students, and 1,000 to 1,500 fellowships a year to help colleges train teachers at the graduate level; matching fund grants to states to improve aptitude tests for grade and high school pupils; grants to give young students better counsel; direct grants up to $125,000 to graduate schools for expansion of teacher training, and increase of $64.5 million to the National Science Foundation for expanded scientific education activities; funds for foreign language training centers.

States would share the costs. Marion B. Folsom, Secretary of Health, Education and Welfare first put the states' portion at $800 million and later said $550 to $600 million. Federal cost would be about $1.6 billion.

Wilsonisms Revived

Three months after leaving the Pentagon, former Defense Secretary Charles E. Wilson has lost none of his ability to give terse answers, discount the Russians and defend his administration. From a copyrighted interview in the New York Herald Tribune last week, these Wilsonisms sounded familiar along the Potomac:

- **"The idea that you have to beat the Russians** at everything isn't going to take the heat out of the world."
- **"Czars aren't in the American tradition.** A czar doesn't sit next to God. The Russians used to claim he did, but he doesn't."
- **"We know more about the Russians** now than we know what to do about it."

On other topics, Wilson made some comments that, like the ones he made in the Pentagon, were almost certain to rile his critics. On the subject of the secret Gaither Report, he said he had never heard of the committee chairman, H. Rowan Gaither, Jr., chairman of the Ford Foundation. And he added, "I don't think his comments are especially valuable."

On the subject of Dr. Clifford Furnas, at one time Wilson's assistant for research and development, now back as chancellor of the University of Buffalo:

"Furnas was one of my poorer appointments. He thought all you needed was more money but he never made a good case for it."

On William M. Holaday, Pentagon director of guided missiles now under fire as a result of the U.S. lag: a "fine" appointment—"good fellow. I had a lot of trouble to find anyone for that job."

Translation Acceleration

Watch for considerable acceleration of U.S. efforts to collect, abstract, translate and disseminate Russian scientific and technical literature under a joint government-industry program outlined for Fiscal 1959. Supplemental budget request for Fiscal 1958 also contains funds for accelerating this work.

Emphasis will be on use of existing government agencies and private and professional society abstracting facilities rather than the creation of a new agency.

Government's role as a coordinator of the country's widely decentralized efforts will be increased. So will government sponsorship of work in private institutions.

Number of meetings already have been held at the National Science Foundation to better organize government's end of things. A meeting between representatives of government agencies involved and editors and translators from private abstracting organizations will be held in Philadelphia late this month to work out a comprehensive, cooperative program.

Those who have been engaged in the work for a number of years feel there is much room for improvement but that U.S. efforts are far better vis-a-vis Russia's than they have been pictured. Greatest need now is more financial support and better coordination, they say.

Sputnik Information

Russians thus far have supplied detailed information about the orbit of Sputnik II, but on nothing else. However, U.S. may have decoded signals from both satellites by now.

Navy sources estimated shortly after Sputnik I was launched on Oct. 4 that decoding might take three months. USAF Maj. David G. Simons of Holloman Missile Development Center indicated at a meeting of the American Assn. for the Advancement of Science last week that Sputnik II's code may have been cracked. Asked if the only information the U.S. had came from Soviet announcements or intelligence sources, Simons said: "Or if we decoded the signal . . . but whatever we do have is highly classified."

Several weeks ago, Pentagon denied reports originating at Holloman that Air Force officers there had decoded the second satellite's signals.

Dr. Joseph Kaplan, chairman of the U.S. committee for the International Geophysical Year, believes Russia eventually will make available much more information on the satellites, and on the dog passenger carried in number two.

—Washington staff

FRENCH Navy Vertol H-21 helicopter, one of eight based at Setif, discharges commandos during combat operation in eastern Algeria.

Special Report From Algeria, Part I:

French Triple Helicopter Strength in War

By Robert E. Farrell

Algiers—Helicopters are the most important combat vehicles to French forces engaged in the Algerian campaign and the French have tripled the number in use in the last year.

The French were operating 270 helicopters throughout Algeria—compared to 90 when AVIATION WEEK first toured the region a year ago (AW Sept. 17, p. 28)—and the buildup isn't over yet.

All three services—Air Force, Army and Navy—now have sizable helicopter units on combat duty in Algeria. Much of the buildup over the past year has come from increased U. S. deliveries of Vertol H-21 and Sikorsky H-34 troop-carrying helicopters. Also during the past year the French have begun operating their five-place turbine helicopter, the Alouette (AW Feb. 4, p. 103), and their two-place jet unit, the Djinn (AW Jan. 14, p. 30). Both these French machines have been integrated into combat with little difficulty and with highly satisfactory performances.

The helicopter buildup over the year, by types and by service operator:

• **French Army.** Last year the Army base at Setif, located on the east central Algerian plateau, was operating 21 Bells, 7 Westland S-55s, 7 Sikorsky S-55s (Pratt & Whitney), 6 Sikorsky H-19s (Wright engine) and 11 Vertol H-21s, a total of 52 helicopters. Today, the Setif Army base has 33 Bells; 19 Alouettes; 20 Westland S-55s; 6 Sikorsky S-55s; 5 Sikorsky H-19s; and 39 Vertol H-21s, a total of 122.

In addition, the French Army recently opened a new base, strictly for helicopter pilot training purposes, in western Algeria at Sidi-bel-Abbes. Here the Army has 14 Westland S-55s and 7 Vertol H-21s for training. Also based at Sidi-bel-Abbes, though just for the time being, are 10 Sud Aviation Army Djinns which operate on mission with the ground forces. Thus, in all, the French Army in Algeria is operating 153 helicopters.

• **French Air Force.** A year ago the main Air Force helicopter base at Boufarik, near Algiers, was operating 15 Bells, 16 Sikorsky H-19s and 10 Sikorsky H-34s, a total of 41 helicopters. Today the Air Force is operating 20 Bells, 16 Alouettes, 19 H-19s and 44 H-34s, a total of 99 helicopters. The Air Force in November, 1956, divided this helicopter operation between Boufarik and a new base at La Senia.

• **French Navy.** A year ago the sum total of the Navy's helicopter operation in Algeria was two Vertol H-21s which the Navy, working with the Army, flew out of Setif. Today Navy has 8 H-21s at Setif and 10 Sikorsky H-19s based at Lartique, near Oran.

The overall total of 270 helicopters in Algeria represents the bulk of France's current helicopter strength. The balance, a few dozen helicopters, are located at various training bases in France. The French Defense Ministry has ordered a total of some 600 helicopters, including 100 Vertols and 220 Sikorsky S-58s, the latter in both the Army and Navy version. Much of the S-58 order will be built in France by Sud Aviation, which holds the S-58 manufacturing license.

There is talk now in Paris that the French Defense Ministry, due to dwindling funds, may order a stretch-out in orders placed for the Alouette and Djinn. It isn't known yet whether this austerity threat will hit the H-21 and H-34 orders as well. But the importance of these two troop-carrying helicopters in the Algerian fighting probably rules out any stretch-out.

The H-21s and H-34s first went into Algerian service early in the summer of 1956. The H-21s are operated by the Army and Navy, the H-34s by the Air Force. The oral battle between Army and Air Force over the relative merits of the two heavy helicopters still goes on in Algeria, and very likely never will be resolved. Evaluation tests in July, 1956, which were held in Algeria, merely convinced each side they were riding the right helicopter.

Army still maintains that the H-21, while admittedly outperformed in certain categories by the H-34, nevertheless fits Army's needs better than the Sikorsky craft. As one Army officer summed it up for AVIATION WEEK, "The H-21 is a truck, the H-34 a racehorse. And we're not in the racing business."

Conversely, the Air Force is more than ever convinced the H-34 is the better helicopter. Air Force officers can cite for a visitor several instances where, they claim, the Army ground command had to use H-34s because the

twin-rotor H-21 couldn't do the job.

Army officers claim to have had the same experience, but with the H-21 coming out on top.

The H-34 is powered by a Wright 1820-84 engine; the H-21 by a Wright 1820-103. The H-34 has a takeoff rating of 1,525 hp., or 100 hp. more than the H-21.

Navy Reconsidered

Only the Navy seems to have somewhat altered its original position. At first, the Navy had plumped for the H-34 along with the Air Force. For one thing, the Vertol helicopter is too big for elevator handling on French aircraft carriers. But when the Defense Ministry told the Navy, which alone of the three services had built up bi-rotor time on 19 HUPs, to operate some of the H-21s in Algeria, it did so. As a result of its H-21 experience, the Navy —while it still wants the S-58 naval version for carrier and training operations —seems as sold on the H-21 as the Army.

Helicopter missions here are almost entirely determined by Army ground force requirements. Both the French Air Force and Navy have had to tailor their helicopter units to meet these requirements, of which the most important is combat troop carrying in difficult and mountainous terrain where average landing altitude is about 4,000 ft.

About 95% of missions carried out by H-21s and H-34s in Algeria are of a troop-carrying nature. In general, these missions are of two distinct types:

• **First type involves** a planned operation, worked out in advance by Army ground command. Here the operation is directed against an area where intelligence reports a rebel band is bivouacked. Helicopters leave their home base with just the flying crew aboard. They fly from 30 min. to 2 hr. before reaching a pre-determined rendezvous site where troops are waiting to be ferried into the combat area. These ferry trips usually take only 10-15 min., with the helicopter rotating between the pickup site and the drop zone. Once the ferry job is over, H-21 pilots wait for possible orders to evacuate wounded.

On a planned operation, particularly when the rebel band is thought to be large and well armed, it is likely that several types of aircraft and helicopters will be used. An initial bombing run is made over the area by B-26s. Then T-6s are called in for strafing just prior to the troop ferrying movement. Before the heavy helicopters move into the area, an Alouette may make a low, fast speed run over the drop zone for a final check and to drop a smoke bomb to give pilots the wind direction. Overhead an orbiting L-19 or Broussard flies observation picket. The entire air-ground operation

ARMY Westland WS-55 (above) from Setif supplies military outpost with beer and bread.

TROOP commander lands Alouette (above). Below, H-21s deliver commandos to combat area.

North American-Columbus Rolls Out T2J-1

First T2J-1 trainer leaves final assembly building at North American Aviation's Columbus, Ohio, Division and is moved to weighing scales prior to painting. Tandem seat T2J has single 3,400-lb.-thrust Westinghouse J34-WE-46 in belly, fed by intakes on either side of nose. Company is completing negotiations with Navy for $37.5 million contract covering undisclosed number of T2Js.

is coordinated by an Army officer who operates from a flying command post, usually an Alouette.

• **Second type** of mission is of a scramble nature. At every helicopter base a certain number of pilots and commandos are kept on a 'round the clock alert. If ordered to respond to a sudden rebel attack, the helicopters take off loaded with commandos, usually 10 to 12, and fly right into the combat area. No ferrying is involved and troops are brought back to the helicopter base.

Air Force Commandos

This type of scramble mission has brought about the development of the French Air Force commandos. Thus, for example, at the Air Force helicopter base at Boufarik there are two groups of 40 "air commandos." When a scramble order comes in, four H-34s take off carrying 10 commandos each. These flights can last one hour or more. Understandably, the development by the Air Force of its own commandos is not one bit welcomed by French Army circles.

Of the two types of helicopter troop-carrying operations—planned and scrambled—more and more are of the planned type. This results from the increase in the number of heavy helicopters now available, as well as from the general improvement in the military situation wherein the French are attacking more than defending.

Rebel firepower over the past year has not substantially improved. Most of the hits registered on helicopters are still in the .30 caliber range. The rebels, however, are losing their earlier awe of the helicopter. A year ago they would run or hide at the sound of a helicopter; today they stay and fight. Captured rebel documents (to avoid the labyrinth of Arab dialects, the rebels write their military pamphlets in French) include manuals on the various type helicopters used by the French forces with instructions on where to shoot to hurt them most. Thus, where last year most of the hits were toward the aft of the helicopter, now the rebels appear to have learned how to lead and are spraying the machines fore and aft.

Not to make it any easier, the French are removing their bull's-eye insignia roundels from all troop-carrying helicopters. When a hit is registered, French mechanics patch the spot and then paint a small star and crescent, the rebel insignia, over the patch.

Commandos Disembark

The French are not attempting to use the H-21 and H-34 as direct assault craft. The helicopters are supposed to disembark troops close to the combat area but not in it. Quite often, however, the lead helicopter comes directly into the combat area without knowing it. When this happens, and if the rebels are well led and well armed, casualties run high. One H-21 caught in such a situation lost all 10 of its commandos during the exiting.

Getting troops out of the helicopter fast has proved to be one of the operating problems. A "jump light" or a horn is the signal to disembark. Ten commandos can exit within 20 sec. On short ferry hops seats are folded back or taken out and commandos sit on the floor. Usually the last man out will give a thumbs-up signal or something similar so the pilot will know he can move out of the area. Unloading accidents are not uncommon. Recently one Air Force commando, loaded with radio equipment, took too long getting out and ended up jumping 20 ft. Pilot reported the commando, who was under fire, got up and ran shakily for cover.

The French have lost some H-21s and H-34s as a result of ground fire, but very few compared with mission hours flown. One H-21 was lost because both pilot and copilot were killed by the same burst of ground fire. Actually, the French have been surprised at the punishment both the H-21 and the H-34 can take from small arms ground fire. Even when several rounds pass cleanly through drive shafts and rotor blades, the helicopter continues to operate without difficulty.

Helicopter Armor

One H-21 on a combat mission was hit 18 times, including eight hits on the rear rotor blades, two in the self-sealing fuel tanks and one in the drive shaft which left a 1¼ in. hole. The helicopter continued its mission and then flew back to Setif for repairs.

So far neither the Air Force, Army

nor Navy have placed any armor on the H-21 or H-34. Air Force officers at Boufarik say they would like to see some light armor plating on the H-34 around the engine area and rotor head. They figure such armor would cost them 175 lb. H-34 fuel tanks always have been self-sealing. Air Force pilots wear flak vests and sit on a French-designed bucket-type seat into which Fiberglas plates are inserted.

Army, on the other hand, doesn't seem to be interested in armor. Vertol armor kits are available at the Setif Army base, but aren't used. Apparently Army officers feel the 115 lb. extra weight is too high a price to pay. Both Army and Navy pilots at Setif no longer seem to bother about wearing flak vests or using Air Force-type armor seats. Army did insist on self-sealing fuel tanks for the H-21, and now more than half the H-21s at Setif have them.

Despite the apparent need for some sort of armed helicopter, no official steps have been taken by the French to provide one or several helicopters equipped to lay down suppressive fire. Both Vertol and Sikorsky have submitted plans along this line to the French authorities. Meantime, however, several experiments with armed helicopters are being made unofficially in Algeria on local command levels.

Armed Helicopter

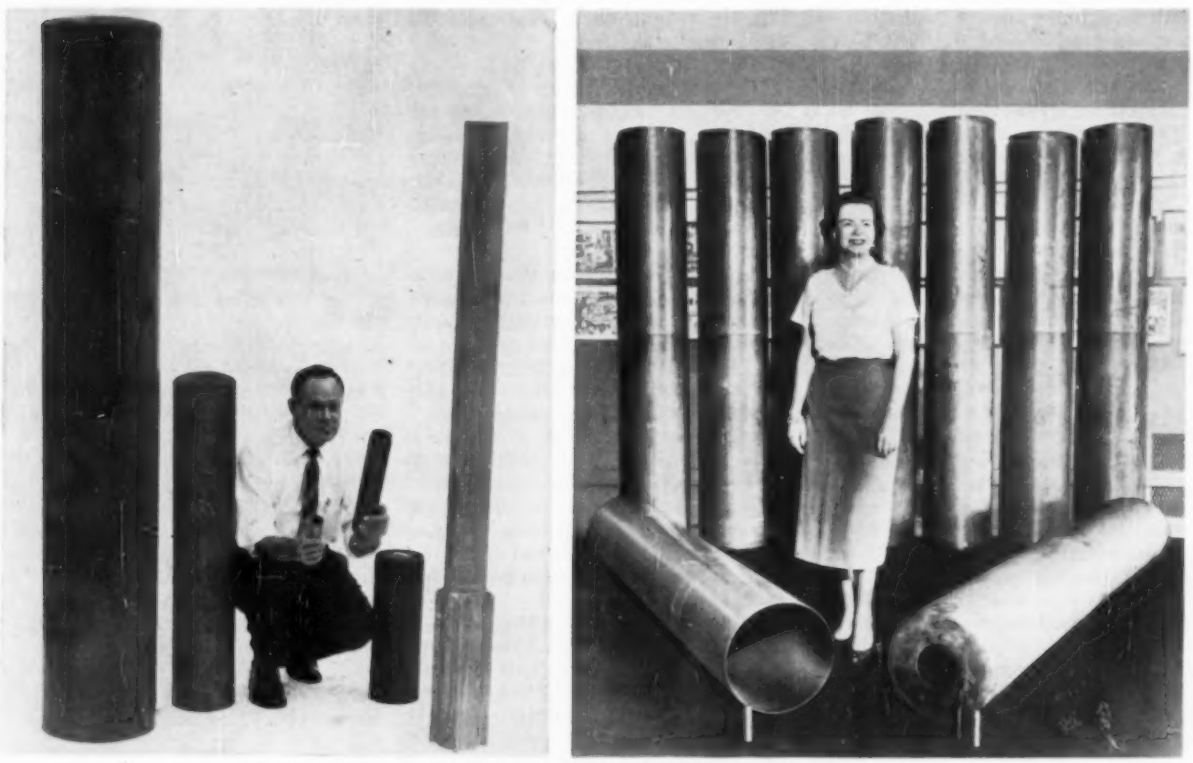
At La Senia Air Force helicopter base, the commanding officer, Col. Felix Brunet, has mounted on each side of his H-34 six rockets and four bazookas which are controlled by the pilot. In the cabin door a light cannon also is mounted while a .30 caliber machine gun is fired out one window and a .50 caliber machine gun out the opposite cabin window. Ship reportedly flies steady while firing. Colonel Brunet has used it in combat.

At Setif, Lt. E. Babot, commander of the H-21 Navy 31F squadron, has rigged up a bomb rack which fits underneath the forward belly area of the H-21. He uses the auxiliary fuel tank arrangement as a dropping mechanism. Ten 250 lb. bombs in two rows of five have been mounted and equipped with proximity fuses. The bombs can be dropped individually or by salvo. Lieutenant Babot also has mounted a bombsight arrangement in the cockpit. He plans to make his bombing runs at 2,000 ft. Initial tests carried out early in December were successful.

Army, while interested in suppressive fire arrangement on the H-21, so far has not joined the Air Force and Navy in local experiments. Army probably will soon equip at least one H-21 with armament similar to that being tested on H-21 in the U. S. This would mean fixing a combined twin .50 caliber machine gun and four-rocket installation on the nose gear. In addition, a .30 caliber machine gun may be mounted in one or both of the H-21 doors.

In theory, for helicopter operations, Algeria—a country as big as the U. S. east of the Mississippi—is divided in half by the fourth degree of longitude. Army helicopters operate in the eastern half, Air Force in the western half. In practice, however, both services cross the dividing line.

Mission orders are handed down by three Army tactical command headquarters: at Oran, Algiers and Constantine. These headquarter groups



Thin Walls Mark Solid Casings

Solid fuel rocket casings manufactured by the Norris-Thermador Corp., Los Angeles, are for (from the left in left photo) Hawk, Sparrow, Army's 38-mm. gun rocket, experimental 70-mm. gun rocket, Falcon and Sidewinder. Rocket engine casings for the solid fuel air-to-ground missile Hawk show their extremely thin walls (right). These light casings give the solid propellant rocket engines a very high engine weight efficiency which in many installations is more important than the higher specific impulse provided by the more complex liquid fuel engines. These Hawk casings are made of 4130 steel and are the largest cylinders ever cold drawn on a conventional press. They have a wall thickness of .106 in. for 44 in. of their length and .0675 for the remainder. This is required because the Hawk has the booster and sustainer engines mounted in the same casings.

also control the use of fixed-wing Air Force equipment used within their territory. A large helicopter operation, for example, can involve bombing runs over the combat area by Douglas B-26s followed by ground support strafing attacks by Republic F-47s or North American T-6s.

The T-6, incidentally, is still the Air Force's most popular "fighter" in Algeria.

The French currently are flying combat missions with 300 T-6s. Generally, the aircraft is armed with four light machine guns and six rockets in underwing mounts.

The T-6s are flown by French Air Force pilots who have been pulled off jets in France for a year's duty in Algeria on the T-6.

Other fixed-wing aircraft flying combat missions in Algeria include the French Noratlas transport and the Max Holste Broussard observation-transport plane. In addition, the French Army operates more than 200 light observation aircraft, mostly Piper L-18s and Cessna L-19s. Army pilots flying these light aircraft average 60 hr. monthly.

French Air Force also keeps some jet equipment on tap, mostly Mistral fighters, though these aircraft are used only when a large-scale operation against the rebels promises a large enough target to justify the expense. Jets are also held in readiness to chase any "pirate aircraft" which might be airlifting supplies to the rebels. There has been no evidence of such activity, but nonetheless the French keep a close watch. At Oran recently, three Mistral jets were scrambled following radar pickup of an aircraft heading for the Algerian interior. Radio response to calls from Oran control were negative. The jets forced the aircraft, a DC-3 with cargo door suspiciously open, to land at Oran. The aircraft turned out to be British Navy out of Gibralter. British pilots sheepishly explained they had been practising cargo-dumping to naval vessels and had lost their way home.

French Army officers, as a result of their considerable combat experience with troop-carrying helicopters, feel that the lessons they have learned can be applied elsewhere. They note that the German Army in the last war, during its Russian and Balkan campaigns, made the mistake of never bothering to develop an efficient defense system against Russian and Eastern European partisans. Many French officers also feel that the use of large troop-carrying helicopters will play an important part in any post-atomic battle where the outcome may be decided by small, well-equipped, mobile forces.

New Congress to Prod Defense Effort

By Katherine Johnsen

Washington—Second session of the 85th Congress which convenes tomorrow will quickly prod the Administration to move faster and further to try to match and surpass Russian scientific and military achievements.

Most congressmen feel that the post-Sputnik steps taken—and contemplated—by the Administration thus far have been only piece-meal moves made to remedy a few glaring inadequacies. These include the acceleration of the missile and satellite programs; the appointment of Dr. James R. Killian, Jr., as President Eisenhower's scientific adviser, and the increased authority of William M. Holaday, the Defense Department's Director of Guided Missiles.

Civil vs. Military

The most far-reaching move the new session will undertake will be an attempt to work out government organization for handling space age problems. Sen. Lyndon Johnson (D.-Tex.), Senate majority leader, says Congress "must lodge—either in a new or an existing agency—specific responsibility for the physical, economic and legal problems of exploring outer space."

This will raise a controversy over civilian versus military control, which embittered the debate over atomic energy in 1946. After the former House Military Committee voted to give the armed services control, a special congressional committee was established which drafted the 1946 act establishing the independent civilian Atomic Energy Commission.

Sen. Mike Mansfield (D.-Mont.), assistant Senate majority leader, and numerous others have proposed a new department for Research and Development, headed by a cabinet-level secretary, to assume direct control in all fields of outer space.

Three other areas in which Congress will also definitely act are:

• **Scientific training.** Some type of federally-sponsored program to stimulate the training of scientists, engineers and other technical personnel from the high-school level on—probably through scholarships and advanced fellowships—has general support.

• **Military pay raises.** Salary increases to encourage skilled personnel to stay in the services also has general support. There is strong opposition, though, to the plan proposed by Ralph J. Cordiner, president of General Electric Co., who headed a Defense Department advisory Committee (AW Feb. 4, p. 37). Sen. John Stennis (D.-Miss.), chairman of the Special Armed Services Subcommittee considering military pay raises, thinks the increases it proposes for generals and admirals are too high and those for lower-bracket officers not high enough.

• **Interservice rivalry.** Demands for reorganization of the Defense Department are numerous. The tendency in Congress is to place major blame for the U. S. lag in the missile-satellite field on interservice rivalry. Democrats criticize the Administration for failing to take firm action to end it.

Johnson Report

Committees will move promptly:

• **Senate Preparedness Subcommittee.** The first major congressional development on the missile-satellite situation is expected to be a report by this influential group headed by Sen. Johnson. Hearings already have been held with civilian scientists and Defense Department officials (AW Dec. 2, p. 31; Dec. 9, p. 31), and are scheduled to resume today.

• **House and Senate Armed Services.** The regular annual briefing sessions of these two standing committees will be extensive this year. The sessions of the House Committee headed by Rep. Carl Vinson (D.-Ga.) begin Jan. 10 and will include consideration of the defense structure and the roles and missions of the services. The Senate Committee headed by Sen. Richard Russell (D.-Ga.) is expected to dovetail its sessions with the investigation of the Preparedness Subcommittee.

• **House Appropriations Subcommittee** on the Armed Services, which will look for low priority items where cuts can be made, will start with hearings on a $1 billion supplemental defense appropriation for Fiscal 1958, which the Administration is expected to submit shortly, and lead into the Fiscal 1959 defense budget, due in Congress before Jan. 22. View of Rep. George Mahon (D.-Tex.), chairman of the subcommittee, is that emphasis should be on using funds already appropriated and improving defense management rather than on large sums of new money. This also is the view of his Senate counterpart, Sen. Dennis Chavez (D.-N. M.), chairman of the Senate Appropriations Subcommittee on the Armed Services.

• **Joint Atomic Energy Committee.** This group, dissatisfied with the administration's failure to accelerate the atomic propulsion programs for aircraft and rockets (AW Dec. 23, p. 25), will hold briefing sessions soon. Deputy

Defense Secretary Donald Quarles, who assured the committee the U.S. missile effort was adequate last August after Russia announced the firing of an intercontinental ballistic missile, will be on the spot.

• **House Government Operations** Subcommittee on the Military. This group headed by Rep. Chet Holifield (D.-Calif.) is ready to start hearings on legislation establishing a Department of Civil Defense headed by a Cabinet-level Secretary to launch a $22 billion shelter program for protection against atomic radiation. Spokesmen for the Gaither Committee, which recommended the shelter program, will be called to testify. The committee, headed by H. Towan Gaither, Jr., chairman of the board of the Ford Foundation, was appointed by the President (AW Dec. 2, p. 28).

• **House and Senate Government** Operations. Both committees have extensive investigations under way on the research and development programs of all government agencies. Sen. Hubert Humphrey (D.-Minn.), chairman of the Senate Government Operations Subcommittee making the investigation, has called for "immediate" integration of all federal technical and scientific organizations into a central agency.

• **House Information Subcommittee.** This group headed by Rep. John Moss (D.-Calif.) will start off the session with hearings to determine ways and means to increase the availability and dissemination of scientific and technical information. Witnesses will be top scientists. The subcommittee will issue reports criticizing restrictions the Defense Department has placed on basic research information and on the Department's information policies, based on hearings last November (AW Nov. 25, p. 28). A Senate Judiciary Subcommittee headed by Sen. Thomas Hennings (D.-Mo.) has made a study and also plans hearings on government information policies.

• **House Judiciary Committee** and the Joint Atomic Energy Committee. These groups will consider aspects of information security looking to scientific cooperation with Western allies. The committee will consider legislation to relax the flat ban on disclosure of atomic information to other nations. The Judiciary Committee will consider the security standards of countries with which the U.S. plans to share classified defense information (AW Dec. 23, p. 17).

• **Small Business Committees.** Both the House and Senate groups—perennially dissatisfied with the small business share of defense business—plan hearings. A special subcommittee of the House committee was appointed a few months ago to study the aircraft industry. Small Business Subcommittee chairman is Rep. Tom Steed (D.-Okla.).

New Home for Convair Atlas ICBM

New $40 million Atlas engineering and production center, built by Convair's Astronautics Division, on northeast outskirts of San Diego, will begin occupancy in March. Administrative, engineering buildings are at left; laboratories and supporting services, right; factory area is in the rear.

Other developments to expect in the new session:

• **Renegotiation.** The renegotiation law, which expires next Dec. 31, appears certain to be renewed. The controversy will be over amendments limiting the discretion of the Renegotiation Board in determining refunds.

• **Military budgeting.** Although legislation putting government budgets on an "expenditure" instead of a "new money" basis had been on the brink of enactment, this does not now appear likely. Defense Department and defense contractors are strongly opposed to it. It would snarl the defense program with new financial complications. W. J. McNeil, Assistant Secretary of Defense, Comptroller, points to the impossibility of estimating actual defense spending a year in advance and the confusion that would result in attempting to keep within the estimate (AW Sept. 9, p. 32). The measure has passed the Senate and been approved by the House Government Operations Committee.

• **Military airlift.** Five congressional committees favoring a shift of more of the traffic of Military Air Transport Service to commercial carriers have been following the situation. A House Government Operations Subcommittee headed by Rep. Holifield will start hearings this week. Senate Appropriations Committee has asked Defense Department for a report on MATS activities by Jan. 15.

• **Capital gains.** Legislation authorizing subsidized airlines to set aside earnings from equipment sales for the purchase of new equipment is a first order of business in the Senate. It has already passed the House and the Senate Commerce Committee.

• **CAB investigation.** The Subcommittee on Legislative Oversight headed by Rep. Morgan Moulder (D.-Mo.) has been scrutinizing the files of Civil Aeronautics Board and Air Transport Assn. since October and is expected to hold hearings in about a month. Objective of the investigation is to determine whether there has been White House or other outside influence on the decisions of the quasi-judicial Board.

• **CAB ethics.** Hearings on legislation setting penalties on the unauthorized disclosure of information by CAB officials and attempts to pressure Board officials are expected to be scheduled by Senate Judiciary Committee. The legislation was introduced by Sen. Henry Jackson (D.-Wash.) as a result of hearings last summer disclosing a premature leak of information on CAB's award of a New York-Miami route to Northeast Airlines.

• **International routes.** Legislation removing the President's authority to review overseas route awards and restricting his authority on international routes for foreign policy and defense considerations faces a Presidential veto even if it is passed by the House. It has been approved by the Senate.

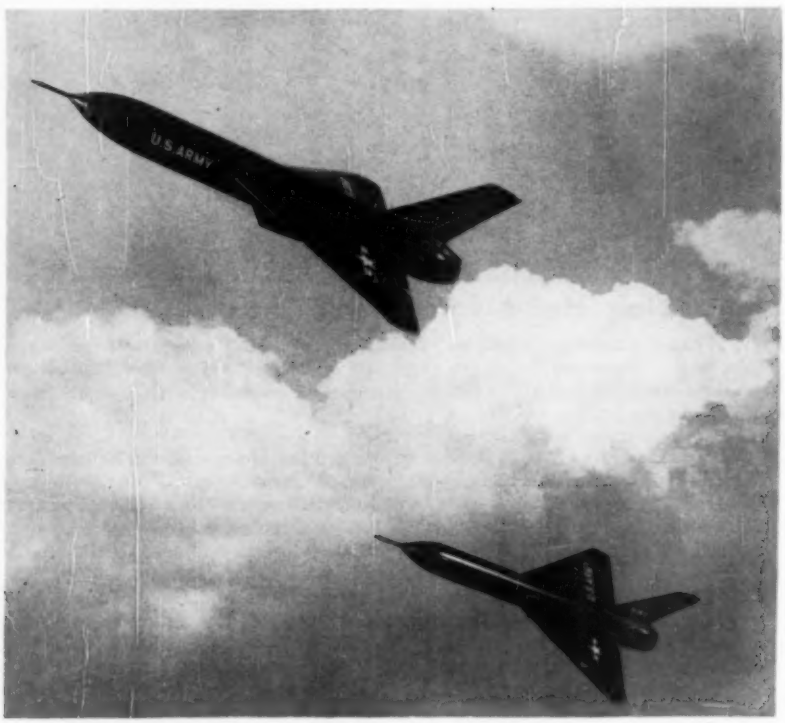
• **Washington National Airport.** Controversy over the location of a new airport to relieve the over-taxed facilities of Washington National Airport seems inevitable again this year, regardless of the site recommended by Elwood Quesada, chairman of the Airways Modernization Board. Civil Aeronautics Administration has $12.5 million for the new airport but is directed not to use the

money until Quesada has presented his site selection to Congress for review by Jan. 15.

• **Liquor on airlines.** Legislation banning this has a good prospect for enactment.

• **CAA personnel.** Senate Civil Service Committee is likely to hold hearings on CAA's personnel practices recently emphasized by the demotion or transfer of six of the seven members of CAA's information staff. The committee's staff has been making an investigation of the CAA's action.

• **Postage increase.** An increase in the domestic airmail postage rate from six to seven cents an ounce will probably be enacted.



Fairchild Developing Surveillance Drone

Army combat surveillance drone under development by Fairchild Airplane and Engine Co.'s Aircraft Division at Hagerstown, Md., is shown in artist's conception. A $12 million contract for the project was awarded earlier this year by the Army Signal Engineering Laboratory.

Semiconductor Device Can Rectify, Control

Syracuse—First semiconductors to be capable both of rectifying and controlling current have been developed by General Electric's Semiconductor Products Department. Called "controlled rectifiers," these devices have been operated in the laboratory at power levels to 1.5 kw. and theoretically can go much higher, making them logical replacements for thyratrons and motor generator sets in many applications.

Controlled rectifiers are pnpn-type silicon semiconductors that differ from conventional silicon rectifiers in that they have a third, or control, electrode. Details of physical construction of the device have not been released by the company for commercial reasons.

General Electric will begin distributing engineering samples of the device internally within the company and to others in the industry early this spring. Most immediate applications will be in power supplies for military electronic equipment and control systems for aircraft and missiles.

Four-layer pnpn devices were first developed at Bell Telephone Laboratories as a reliable replacement for latching relays and thyratrons used in telephone switching. Similar devices have been developed at RCA and Shockley Semiconductor Laboratory. All of these devices, however, are for the switching of low level signals only; they will not handle significant amounts of power and do not control the current flowing through them.

According to General Electric, there are only practical limits to the power handling capabilities of controlled rectifiers because, as in conventional silicon rectifiers, the permissible current flow is a function of the semiconductor boundary area and the efficiency of the cooling method.

Problems in manufacture, however, probably will keep the cost of these devices high and production limited for at least a year. These problems involve maintaining extreme uniformity of impurities in both the n and p layers and exact alignment of the layer boundaries.

The controlled rectifier operates in much the same way as a conventional thyratron. During the alternating current half cycle when the rectifier is able to conduct, the amount of current flow is controlled by means of a gate current pulse applied to the third, or control, electrode.

The gate current pulse controls the amount of current flow by varying the point in the conduction cycle where the device fires in the same manner as a thyratron. Both operate on the principle of phase control.

Typical laboratory samples fire with a gate current pulse of 10 ma. at ½ v. Maximum current required for firing is 25 ma. With these low level control signals, the forward-going current can be controlled over a range from a minimum applied voltage of about one volt to the breakover voltage of the unit.

Breakover voltage is that voltage level where the controlled rectifier will conduct whether a gate current pulse is applied or not. With present samples the range of breakover rating varies between 25 and 200 v.

Existing controlled rectifiers have been operated at 200 v. and 5 amp. with the stud (case) temperature maintained at 125C. These units use an effective semiconductor area of about 0.1 in. General Electric believes that with this same size device maximum ratings of 300 v. at 10 amp. are attainable.

The company stresses that all of the present devices are experimental. Although controlled rectifiers may well monopolize more than one third of the total semiconductor rectifier market eventually, a large amount of basic work remains to be done before these devices can be produced simply, cheaply and in quantity.

Jordan May Purchase Hunters From British

Beirut, Lebanon—While Syria and Egypt arm with Soviet MiGs and Ilyushins, Jordan reportedly is showing interest in buying British Hunter jet fighters.

A representative of the Hawker Aircraft Co. will visit Amman shortly to negotiate a purchase with the Royal Jordanian Air Force.

Jordanians are said to be interested in getting as many as two squadrons of Hunters—about 24 aircraft.

AMB Favors General Precision Proposal

By Philip J. Klass

Washington—General Precision Laboratory has won out over 13 other bidders in Airways Modernization Board competition to select a contractor to develop a semiautomatic traffic control data processing and display system.

Program represents the most ambitious and comprehensive development project ever undertaken for common system use. It also is the first civil use of the single-contractor weapon system approach which the military has found so successful in the development of complex systems.

General Precision Laboratory's selection is called "tentative" by AMB Chairman E. R. Quesada pending negotiation of a firm contract which is expected to take approximately two weeks. Until a contract is signed, General Precision Laboratory will not release any details.

Because none of the proposals received by AMB had all the features it believes are needed, the agency wants to include them in the development task before signing a contract with General Precision Laboratory, according to an AMB spokesman.

General Precision Laboratory will be assisted by Librascope and Link Aviation, both sister subsidiaries of General Precision Equipment Corp., and by Tasker Instruments Co.

Winning Features

Many observers viewed General Precision Laboratory's selection as a dark horse winner in the face of competition from giants like Hughes Aircraft, International Business Machines Corp., and from Sperry Rand, Radio Corporation of America and Airborne Instruments Laboratory which submitted a joint three-way proposal.

Winner's proposal was judged superior on basis of easy transition from existing techniques and procedures to the new semiautomatic system. In the past there have been numerous ideas suggested for elaborate automatic traffic control schemes but most of them failed to consider the problem of how to make the transition from the present system.

Another point of superiority, according to an AMB spokesman, is the "ingenious" fail-safe backup provisions in General Precision Laboratory's system which permit safe traffic control despite sudden failure of one of the new electronic data processing-display devices. Flight progress strips will be retained, but will be printed automatically and brought up to date despite such failures.

Novel techniques for path stretching to keep aircraft on schedule, both en route and in the terminal area without resorting to off-airways curved paths, were another notable feature of the General Precision Laboratory proposal.

The development of these techniques is credited, at least partially, to Vernon Weihe, Air Transport Assn. engineer who also works for General Precision, and Homer Tasker, whose company will work with General Precision on the program.

System proposed by General Precision Laboratory also is believed to include provision for flight plan tracking by means of computers which will automatically keep tabs on each airplane position throughout its flight. From original flight plan, brought up to date periodically by pilot position reports, or radar data, when available, computer will be able to calculate pilot's estimated arrival over fixes and automatically provide data display on the aircraft to traffic controller requiring such information.

Pushbutton Transfer

The General Precision Laboratory system is believed to permit traffic controllers to transfer flight data and control to other controllers in adjoining Air Route Traffic Control Centers or terminal areas by pushbutton without the time-consuming voice communications now required.

Bell Telephone Laboratories studies show that smooth traffic flow breaks down in the existing system whenever controller must spend more than about 30% of his time in communication chores.

Bell's analysis indicates that controllers now spend as much as 70% of their time in communications. The new General Precision Laboratory system is expected to greatly reduce this drain on controller time.

The General Precision Laboratory system also may include automatic conflict detection, with the traffic control computers continuously scanning the present position, altitude, speed and expected flight plan of all aircraft under control for possible collision hazards. Resolution of such conflicts will be left to the judgment of human controllers and will not be attempted by the computers, although the latter may compute possible alternative actions for controller choice.

Airways Modernization Board philosophy is to use automatic computers only to make choices which can be based on strict rules that apply under all situations and conditions.

Three Judging Teams

Each of the 14 proposals was submitted in three volumes, one dealing solely with operational aspects of the system, one with technical details and the third with company background, personnel and facilities.

Three teams, each consisting of six experts, were formed to evaluate the proposals. One team, consisting of six traffic control and operations experts, rated only the part of the proposal dealing with operational features, while the second team, consisting of engineers and computer experts, evaluated the technical portion of the proposal. When proposals had been individually scored by the appropriate teams, the ratings were combined and General Precision Laboratory came out on top. Only after a qualitative evaluation were the prices submitted by bidders taken into consideration.

Airways Modernization Board says that other companies that submitted proposals may participate in portions of the total program under General Precision Laboratory's leadership.

Soviet 'Graviplane'

Moscow—Kirill P. Stanyukovich, Soviet doctor of technical sciences and a prominent astronaut, reported last week that Russia is working on an aircraft "not subject to the laws of gravity" for space flight.

Stanyukovich was quoted by Tass news agency as saying "the problem of gravitation will be clarified to some extent in the forthcoming year." Name given to the aircraft by Stanyukovich is "graviplane."

AEC Renews Contract With United Aircraft

Washington—Atomic Energy Commission last week renewed its contract with United Aircraft Corp. for development of an aircraft nuclear propulsion system amid reports that the White House is prepared to revive emphasis on the entire military atom plane program.

If the Pentagon is ordered to reverse the slowdown decision of early last year, it would probably be for propaganda and prestige purposes rather than because the Air Force and Navy need the weapon as soon as possible.

There are strong indications, taken seriously in both military and industrial circles, that the Russians will fly an atom-powered aircraft possibly within a year. It is expected that the

Soviet effort will be merely to get something off the ground—probably a turboprop Bear bomber, modified to use nuclear propulsion.

USAF already has dropped its interest in the Pratt & Whitney project and left AEC alone as a contractor with the engine division of United Aircraft (AW Aug. 19, p. 34).

AEC's action last week was to renew its cost-plus-fixed-fee contract extending it to Sept. 30, 1960. The work, started originally in May, 1953, and will cost about $15 million a year.

The Pratt & Whitney work aims at the design of a reactor suitable for use in an advanced aircraft propulsion system. USAF has another contract with General Electric for a different type reactor and related jet engine.

Both Lockheed and Convair are busy on designs for an airframe.

West Germans Remain Silent On Advanced Interceptor Choice

West German orders for an advanced interceptor appear to be unlikely for another month and may well not be placed until early spring despite a spate of rumors last week that the Lockheed F-104A Starfighter had won out following the German rejection of the Saunders-Roe SR. 177.

Comparative evaluation of the F-104 and the Grumman F11F-1F Super Tiger at Edwards Air Force Base was completed by a German air force team, but the Germans were noncommittal as to which airplane they preferred. They said only that they liked both.

One other airplane is still in the running—the French Dassault Mirage III. This is a rocket-turbojet powered interceptor like the British SR.177, which was intended to be a 2,000 mph. plus fighter capable of operating above 100,000 ft.

Although British newspapers charged the SR.177 was rejected because of U.S. pressure, the Germans said it was because the airplane would not be in quantity production until 1961 and the Germans did not want to commit themselves heavily to an unproven airplane.

Northrop's N-156F, a fighter version of its T-38 trainer, also would fall into the same category, but no formal rejection of it was made. One reason given for the formal rejection of the British fighter was that the British had insisted on a yes or no answer before Dec. 31.

In canceling the SR.177 development contract, a British Ministry of Supply official said:

"This aircraft commands general recognition as an excellent and unique design in its class. Unfortunately, it no longer fits into the broad pattern of the United Kingdom defense program as outlined in the Defense White Paper of April, 1957."

Saunders-Roe says withdrawal of government support means the rocket-jet fighter project will be dropped. It had been continued only in hope of a West German order.

Naval interest continued in the new aircraft, which was to be powered by a de Havilland Spectre rocket engine and de Havilland Gyron Junior turbojet. But the manufacturer says the naval requirement is not for a sufficient quantity to justify the development cost.

The decision to drop the mixed-power interceptor is a blow to one of the most promising new British aircraft.

"The particular advantage of the mixed unit aircraft is its versatility," said Saunders-Roe Chief Designer M. J. Brennan. "For example, its total engine installational weight may be only about 10% of the takeoff weight, whereas the corresponding figure for the pure-jet type is about 25%. It is true that the mixed unit aircraft will carry a greater percentage of its takeoff weight in fuel and oxidant. But the landing weight, with rocket propellants consumed, is very low and the byproduct of this apparent disadvantage is the ability to land on comparatively small runways. Takeoff from the same runways naturally presents no obstacle in an aircraft with such a reserve of power."

The only other major airframe project at the Saunders-Roe plant is the two-seat Skeeter helicopter. Fifty of these are under construction for the British and West German governments. In addition, the firm has been handling subcontract work on Viscount and Valiant subcomponents.

It is understood now that the smaller procurement order from Germany will be for only about 100 airplanes instead of 250-300 originally contemplated.

Other reasons reportedly responsible for the rejection include:

- **Decisive shift** in defense ministry thinking in favor of heavier reliance on missiles for air defense.
- **Fresh spurt** of interest in a vertical takeoff aircraft becoming operational sooner than anticipated; possibly around 1963-64.

Grumman Wins Attack Competition

Contract for the development of a new high and low altitude, two place, turbojet-powered, carrier-based attack aircraft has been awarded to the Grumman Aircraft Engineering Corp., by the Navy Department. Grumman's winning proposal was one of several being considered in the Navy design evaluation. Chance Vought and Douglas were among the companies participating in the competition.

Description of the design and its estimated performance are classified, but the fact that it is intended to operate at low altitude indicates it will have good endurance and handling qualities at subsonic speeds.

Order for F8U-3

Washington—Navy last week awarded Chance Vought Aircraft a $100 million contract for initial production of the F8U-3 advanced all-weather mixed powerplant fighter.

The contract followed on the heels of a $200 million contract for production of the F8U-2 and continued production of the F8U-1 Crusader (AW Dec. 2, p. 26). In configuration, the F8U-2 closely resembles the F8U-1. The F8U-3, however, is essentially a new aircraft. Powerplants will be the Pratt & Whitney J75 and a rocket motor.

Navy officials said no decision has yet been reached as to whether to continue development of the McDonnell F4H-1 all-weather fighter and said the aircraft is still being evaluated.

Lockheed Notes Gain In Missile Projects

One third of Lockheed Aircraft Co.'s advanced projects are being carried out at Sunnyvale, Palo Alto and Van Nuys, Calif., within the firm's mushrooming Missile Systems Division, Board Chairman Robert Gross reported.

"Missile sales represented 8% of Lockheed's all-time record total of more than $900 million in 1957. This proportion is expected to climb to 20% in 1958 as work is accelerated on various programs, including Navy's long range fleet ballistic missile, the Polaris," Gross said.

Exceptionally heavy deliveries of commercial airlines plus growing missile activity were major factors in the 21% rise of sales for 1957 over the $743 million reported for 1956.

Lockheed expects its backlog during 1958 to average close to the $1,300 million total at year-end 1957, Gross said. But he forecast a greater proportion of it will be in missiles.

The company estimates sales next year will total about $750 million, a decline from the 1957 level.

Eye in the Sky

SITUATION: *A range of hills screens enemy activities.*

TACTICAL PROBLEM: *What is on the other side of the hills?*

SOLUTION: *Aerial drone surveillance—puts an "eye" in the sky.*

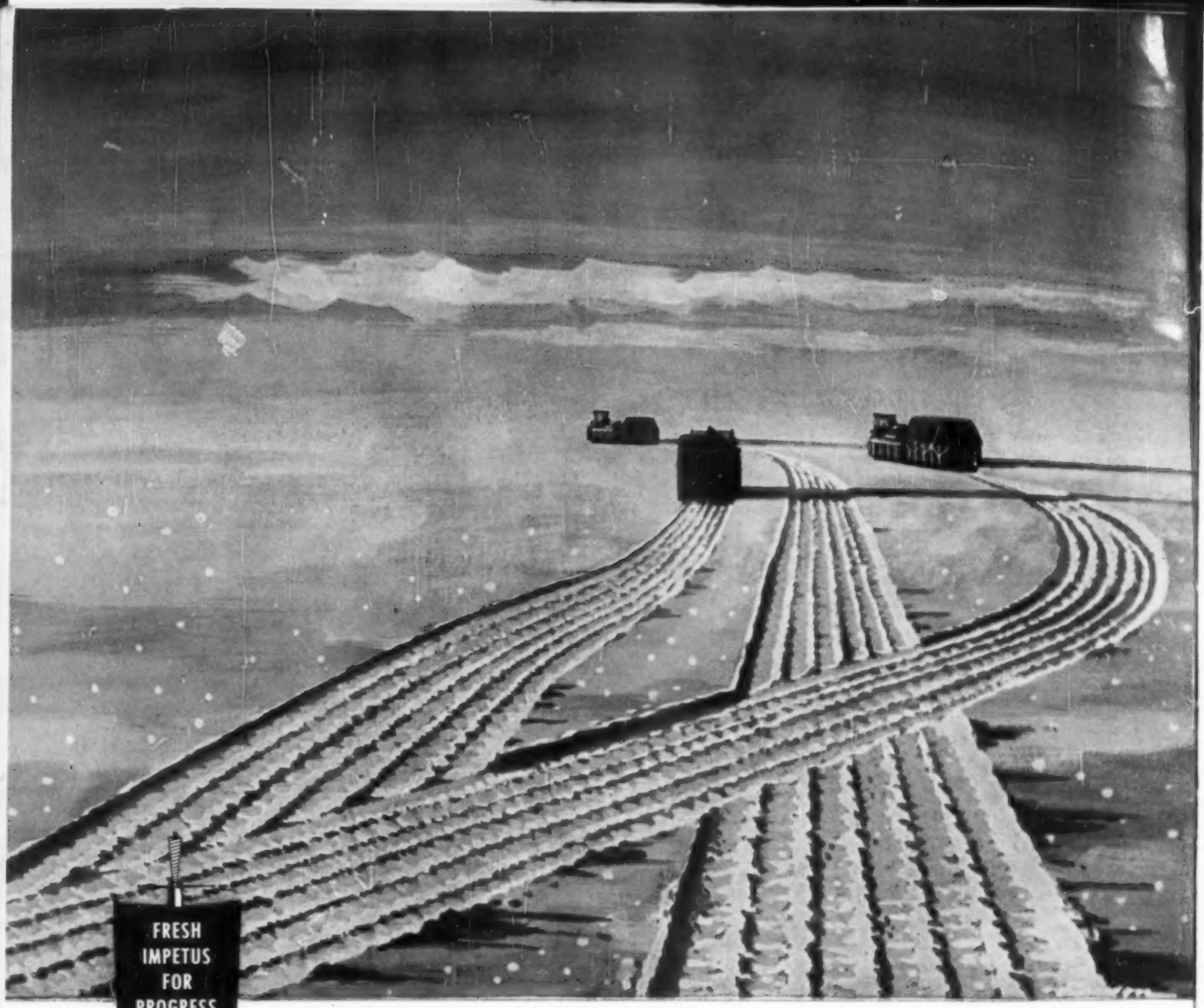
Radioplane, in conjunction with the U.S. Army Signal Corps, developed and is producing the SD-1 surveillance drone system. Highly mobile, the camera-carrying SD-1 may be zero-length ground launched in rough terrain from a camouflaged position and flown by remote control over enemy installations on photo reconnaissance missions. After the drone's camera has exposed its film by radio command over the target, the SD-1 is then flown to a pre-designated area for parachute recovery. The camera is removed, the film is processed, and prints are delivered to the requesting unit within minutes after the entire operation began and the mission is accomplished without risking a pilot's life or a large man-carrying aircraft.

The Signal Corps SD-1 surveillance drone system is another example of Radioplane's constant refinement of the art of producing radio-controlled drones. First to manufacture target drones exclusively for military use Radioplane has a world-wide field support organization with personnel qualified to assist in all phases of drone field activities.

RADIOPLANE

A Division of Northrop Aircraft, Inc.

VAN NUYS, CALIFORNIA AND EL PASO, TEXAS



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CA57-UST-8

Adm. Wright Says Fleet Requires Better Anti-Submarine Equipment

By Claude Witze

Washington—U. S. Atlantic Fleet is at its highest state of readiness since World War II but still needs improved aircraft, helicopters and detection equipment to meet the threat of Soviet submarines, Adm. Jerauld Wright, the fleet's commander and chief of North Atlantic Treaty Organization forces in the Atlantic, said last week.

Adm. Wright said the new U.S. budget should include improved support for research and development activity in areas that will contribute to anti-submarine capability.

Anti-submarine warfare, the admiral said, is his number one problem. During 1957, the fleet's defense force was tightened with the formation of an anti-submarine command. It has full responsibility for preventing an attack from underwater ships on the United States.

Adm. Wright said the fleet's ability to use atomic depth charges against enemy submarines is a big advance, but he pointed out that the weapon is so lethal it cannot be used by surface ships. It must be dropped from aircraft. At the same time, he said he would not use the atomic depth charge at all if conventional blasts could do the job. The admiral looks upon all atomic weapons as offensive and indicated they will be used in a defensive role only as a last resort.

In his emphasis upon the need for a stronger research and development effort to help improve ASW equipment, Adm. Wright indicated that he has strong reservations about the practicability of centering this work in a single Defense Department agency. Secretary of Defense Neil H. McElroy is preparing to create a new Advanced Research Projects Agency, or single manager, to develop new weapons.

Adm. Wright indicated that he favors the full utilization of civilian research and development capability already in existence—in industry and government agencies—over the creation of a new organization in the Defense Department.

The admiral pointed out that, while good progress is being made on the Navy's Lockheed-built Polaris intermediate range ballistic missile, so far there is no submarine from which it can be launched. This vessel must be designed and built along with experimental surface ships to serve as possible launching platforms for the new IRBM, now optimistically promised for operational capability in 1960.

Adm. Wright said the NATO fall exercises served a good purpose in uncovering both strengths and weaknesses in the allied sea effort. He reported that there was good coordination among the member navies.

On the other hand, communications proved a major weak point. Particularly in northern waters, he said, the problem never was satisfactorily worked out, due in large part to natural interference from the limitations of existing equipment. The admiral said personnel limitations also were a big factor, due mainly to the lack of skill in both regular Navy and reserve personnel on duty for the NATO exercises.

The admiral said both attack and air defense capabilities of the Atlantic Fleet were strengthened in 1957 by first deliveries of the Grumman F11F Tiger and Chance Vought F8U-1 Crusader. He said very few of these aircraft have been delivered.

Adm. Wright said the Navy can make a strong case for the necessity of accelerating deliveries in view of the Red submarine threat but added that he does not know of any plans to ask Congress for an accelerated aircraft delivery program.

More Money Urged For Small Firms

Washington—Senate Small Business Committee last week called for a "trigger" to touch off a more dynamic approach toward small business in the award of defense business.

Defense Department's attitude toward small business during the past year, the committee charged in its annual report, has "again been characterized by lethargy, inaction and procrastination."

Army, the committee declared, "has become somewhat complacent about its small-business programs, choosing to rest its case on its high per cent of awards to small business. . . . Seemingly overlooked by top Army policymakers is that the nature of the supplies being purchased by the Army lend themselves to being furnished more readily by small business than is the case with Navy and Air Force purchases."

Air Force's true attitude toward small business, the committee said, "is hard to fathom." It said that despite assurances of a "sincere and dedicated interest," actual developments force it to conclude "that the discouraging percentage of Air Force small business awards is not solely attributable to the nature or type of item being procured."

Navy's small business efforts, on the other hand, were praised. Navy's efforts were "characterized by hard work and a willingness to implement fully all procurement procedures designed to assist the small business program." The committee concluded:

"The problems faced by small business in its efforts to do business with the Department of Defense are almost too numerous to record. However the most significant and fundamental of all is the basic, though well-concealed, attitude of indifference to the program maintained by that vast and powerful middle-management group consisting of contracting officers, buyers, negotiators, and those technicians drafting supply requirements."

Small Business Orders

Washington—Department of Defense reported last week that small business firms received over $3.4 billion in defense subcontracts during Fiscal 1957 from 216 prime contractors who took part in the small business subcontracting program.

The figure does not include subcontracts by prime contractors not participating in the program, or second-tier small business subcontracts from large concerns who obtained $5.6 billion in direct subcontracts from the 216 concerns.

In addition, Defense Department reported that $3.8 billion in prime contracts were awarded directly to small business firms by Army, Navy and Air Force during Fiscal 1957. This represented 19.8% of the total $19 billion awarded to all business firms.

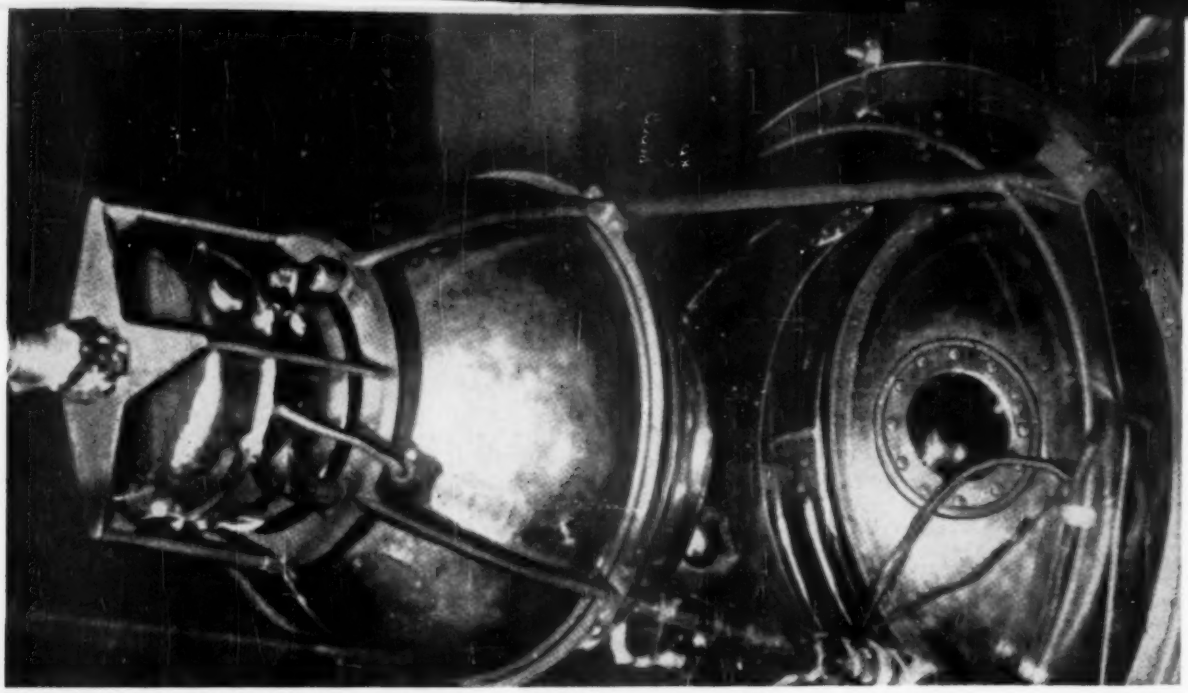
Layoffs, Salary Cuts Planned by Vertol

Morton, Pa.—Faced by a serious production lull in 1958, Vertol Aircraft Corp. today will slash the pay of salaried employes from 10% to 30% and start cutting another 1,000 persons off the payroll.

By the end of March, Vertol's payroll will be down to 2,000 employes. At the beginning of 1957, it was 4,800.

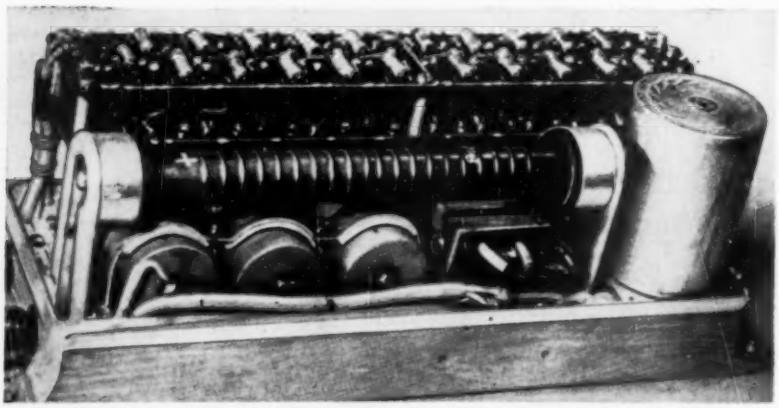
President Don R. Berlin said the action is being taken to bring costs into line with sharply reduced output. Revised Army requirements early last year forced a slash in H-21 procurement.

Despite this, Berlin said Vertol "is in a more solid position in respect to the future than we have ever been." He cited the company's investment in developing turbine-powered helicopters, two of which currently are being demonstrated to the military services and commercial operators.



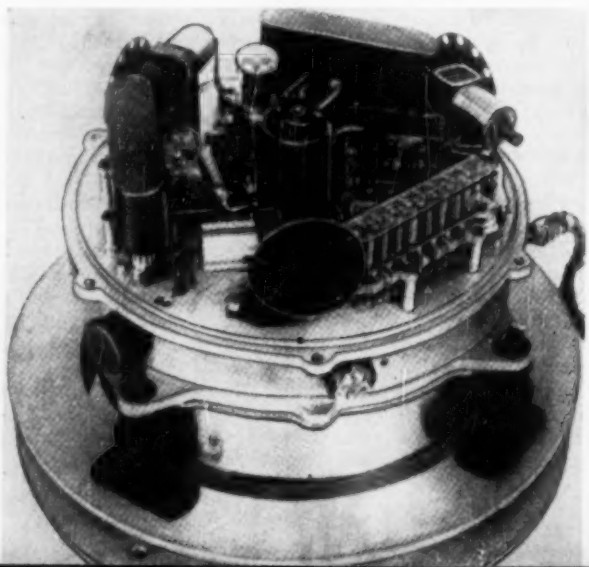
SPUTNIK II's forward section without protective nose cone which fastens to ring at right.

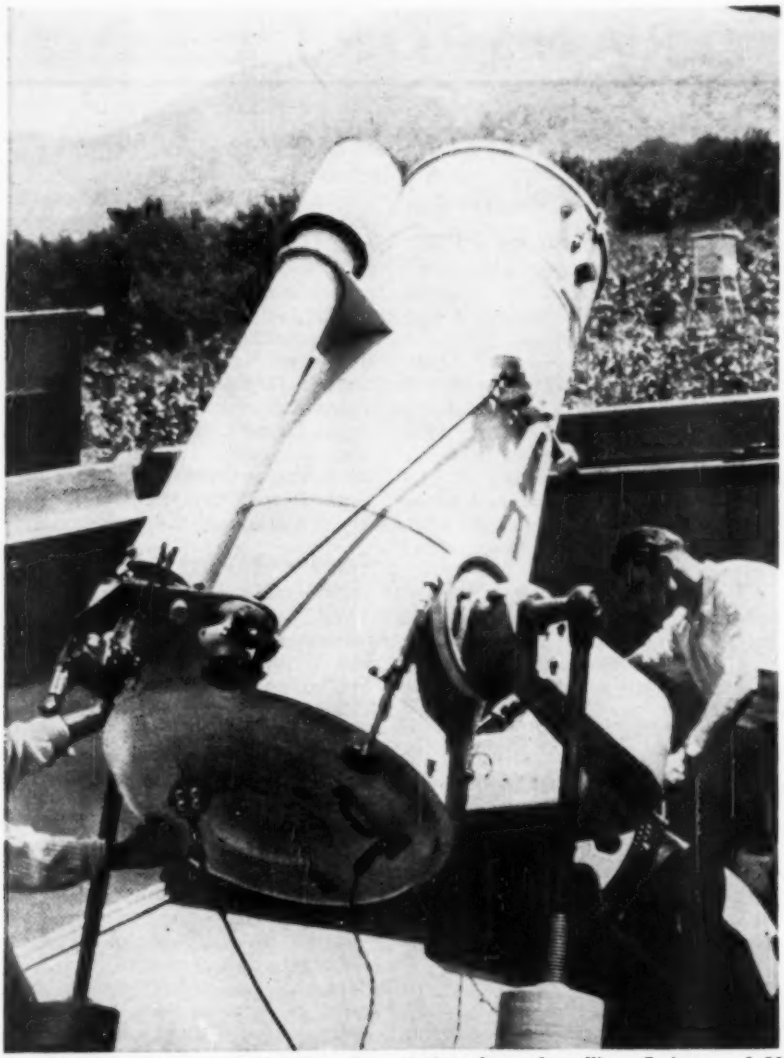
Photos Show Sputnik II Instrumentation



IONIZATION chamber for cosmic ray detection (above). Sputnik II's ultra-violet and X-ray detectors (left, below) and Soviet radio telescope (right below).

Instrumentation for Sputnik II includes detectors for solar radiation (extreme left above) and capsule containing cosmic ray detector and two radio transmitters (center above). Laika's cabin is at right. Instruments show that little attention was given to reducing size or weight. Soviets say they track satellites optically, by reception of telemetry signals and with long range radar.





KAZAKHSTAN observatory's telescope for optical tracking of satellites. It is one of 66 special tracking stations.

METEOR tracker used for photographing and calculating orbits of Sputniks I and II.

More 1958 Money Planned for Polaris

Washington—Navy plans to accelerate further its top priority project, the Polaris intermediate range fleet ballistic missile, by allocating as much as $50 million more from Fiscal 1958 funds.

Parallel emphasis is being directed toward development of nuclear-powered submarines specifically designed to carry Polaris. Late introduction of these undersea launchers would delay the missile's pre-operational test phase and its following operational status. If specific submarines designated for Polaris service are not ready in time, the Navy probably will jury-rig existing undersea craft to fill the gap.

Polaris prototype design is fixed, but changes are being considered to make the final production missile radically smaller than its counterparts Thor and Jupiter because of space limitations inherent in underseas carriers. The 47 ft. length reported for the missile may be cut appreciably before the design is made final.

Under present development plans, the prototype may be fired during 1959. Test units fired at Cape Canaveral have included a 30-ft. model not specifically related to the Polaris design but used to check out components. Another 30 ft. test unit is scheduled for launching this month.

Lockheed Aircraft Corp., missile system manager and prime contractor for the Polaris, has responsibility for development of the nose cone, as well as airframe and test program. Use of beryllium for nose cone service is being actively pushed by the company's Missile Systems Division because of the material's light weight, high strength-weight ratio at high temperature and high specific heat.

The metal's chief drawback—brittleness—may be alleviated by metallurgical development by the time Polaris becomes operational.

Atlas Meets Police

San Diego—Truck carrying an Atlas intercontinental ballistic missile from Convair's San Diego plant to the Air Force Missile Test Center, Cape Canaveral, Fla., recently ran into trouble with the California Highway Patrol.

The truck was halted in the Imperial Valley, and its driver given a ticket for illegal use of the flashing red lights employed to warn motorists of the giant vehicle's approach. Afterwards, the truck was forced to continue through California with its warning beacons turned off. The red lights were switched on again once the truck crossed the border into Arizona.

New Period of Uncertainty Faces TWA

Burgess resignation leaves TWA in same leaderless state that followed death of Ralph Damon in 1956.

By L. L. Doty

Washington—Resignation of Carter L. Burgess as president and director of Trans World Airlines has thrown the carrier back into the state of turbulence that in 1956 pulled a 1955 net income of $5.4 million down to a net loss of $2.3 million.

After a full year of relatively peaceful operation under the leadership of Burgess, TWA is again faced with another indefinite period of uncertain management direction. The airline floundered through 1956 following the death of former President Ralph Damon early that year without any designated chief executive.

Increased Earnings

Burgess, who accepted the presidency last Jan. 23, resigned "because of a disagreement over airline policies." He is believed to have differed on a number of policy points with Howard Hughes, president of the Hughes Tool Co. which now owns 77% of TWA's outstanding stock. Hughes' proposed equipment program is thought to be a major source of contention.

During his one-year stay as president, Burgess appeared to have pulled the airline back into the first stages of recovery from the 1956 financial debacle. During the first nine months of 1957, the airline earned a net income of $2.4 million after taxes and reversed an industry trend by cutting costs per available ton-mile on both domestic and international routes.

It is possible, however, that the disappointing traffic decline experienced by all airlines during the last three months of the year may wipe out an appreciable part of the nine months income. In any event, Burgess had made substantial progress toward solidifying the carrier's position within the industry and insuring a sound future operation.

The 1956 loss was the first financial setback experienced by TWA since 1948. Under Damon, who was president between 1949 and early 1956, the airline prospered and consistently reported annual gains which reached a peak in 1954 with a net income after taxes of $10.3 million.

One of Burgess' chief goals upon accepting the presidency was a tightening of management functions and improved managerial judgment. He also adopted a cost-cutting program that resulted in a personnel cutback of about 5%. The action caused a drop in personnel morale, particularly at second echelon level. The present hiatus between presidents is not likely to help restore a higher morale tone within the company.

Equipment Views

Burgess has shown a deep interest in TWA's ambitious jet program which involves 30 Convair 880 jet transports and 33 Boeing 707 jet transports. He has, however, approached the jet future cautiously and in an interview with AVIATION WEEK early last year (AW Feb. 4, p. 41), he said it was too early for him to discuss jet equipment requirements of TWA.

He has worked closely, however, with his jet planning committee and his special advisor for jet planning, Robert N. Buck. The TWA forecasts for jet costs produced by the committee (AW Oct. 14, p. 38) is one of the airline industry's most comprehensive.

Hughes has been intensely interested in supplementing his turbojet orders with orders for a fleet of turboprops. He has seriously studied the Vickers Viscount and is known to be considering the purchase of 25 Lockheed Electras and at least 15 Bristol Britannias.

Why the Split

Most observers feel that the split between Hughes and Burgess stems from Hughes' determination to add both types of turboprops to the turbojet fleet on order. Burgess had evidenced a close interest in the airline's maintenance and operational programs and sought to achieve more flexibility in equipment scheduling as a means of correlating flight direction with traffic flow.

Burgess may have rebeled against the possibility of an operation that would involve the maintenance of four different types of engines, one British.

Burgess admitted two months ago that he had never met Hughes. Prior to that, Hughes was busying himself studying turboprop equipment without any noticeable evidence that TWA

United's Boeing 720

United Airlines markings are shown on drawing of Boeing 720 jet transport. United has ordered 11. Medium range 720 has shorter fuselage than 707 transport, with 48 cabin windows as against 54 in the 707. The 720 will carry 100-125 passengers.

management was being brought in for consultation on the studies.

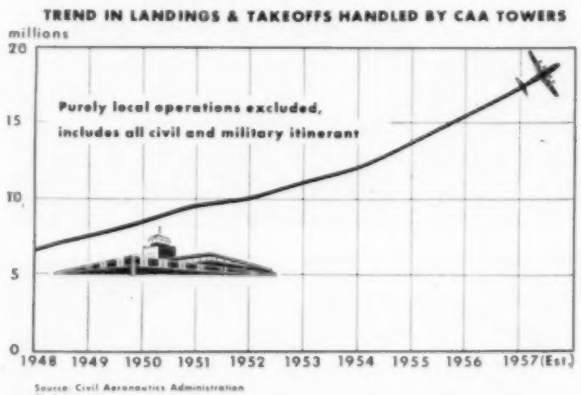
Hughes acknowledged Burgess' interest and drive in operating the airline in his official announcement of the resignation by saying that "Mr. Burgess has brought great energy, dedication and devotion to TWA in the year he has served the airline, and I regret that we simply cannot agree on airline policies."

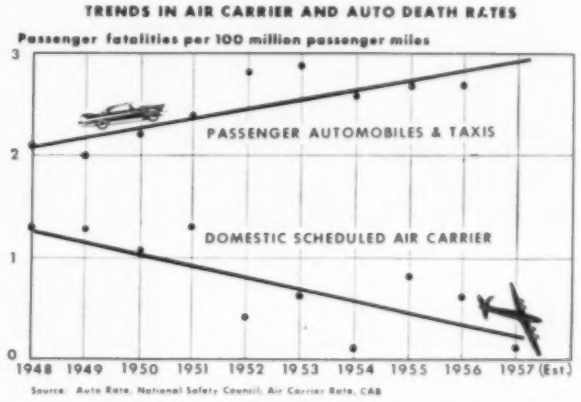
Both Burgess and Hughes described the resignation as a "friendly" one brought about by disagreement over airline policies. The resignation was accepted by TWA board "with regret."

This is the second time that Burgess has resigned from TWA. In 1947, he left the company to follow TWA President Jack Fry who resigned to become president of the General Aniline and Film Corp. Later, Burgess was named assistant to the president of the University of South Carolina.

Before joining TWA last year, Burgess had served as an Assistant Secretary of Defense under Charles E. Wilson. He said at the time of his election to the TWA presidency he had been surprised by the offer and had contemplated returning to South Carolina when he left the Defense Department.

No successor has been named for Burgess although Warren Lee Pierson, chairman of the board, is expected to guide management policy until a new president is named. In 1956, Executive Vice President John Collings served as acting president but resigned from the company when Burgess took over. But Collings held his membership on the board and served as a special consultant to the board and president.




TRENDS IN AIR CARRIER AND AUTO DEATH RATES
Passenger fatalities per 100 million passenger miles
3
2
1
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PASSENGER AUTOMOBILES & TAXIS
DOMESTIC SCHEDULED AIR CARRIER
1948 1949 1950 1951 1952 1953 1954 1955 1956 1957(Est.)
Source: Auto Rate, National Safety Council; Air Carrier Rate, CAB

CAA Reports Increase in Civil Aircraft

Washington—Civil Aeronautics Administration last week reported a 25% increase in the number of large civil aircraft manufactured during 1957 over 1956 and a 73% increase in the dollar value of shipments of complete aircraft and parts.

In its annual statistical summary of civil aviation activities, the CAA also reported a 21% increase in instrument flying during the year. At the same time, the scheduled airlines attained one of their safest flying records, with a passenger fatality rate of two-tenths per 100 million passenger-miles.

Previous best safety record was in 1954 when a five-tenths fatality per 100-million passenger-miles was achieved. In 1957, there were five accidents on domestic and foreign scheduled U.S. operations, involving 67 fatalities.

To handle the increase in the volume of instrument flying, the CAA increased its air traffic controller personnel staff from 9,100 to 10,500 during the year. A total of 43 very high frequency omnidirectional radio ranges (VOR), were installed during the year to help cope with the traffic rise.

Contracts let by the CAA during the year were in excess of $74.5 million for the purchase of equipment. Key items ordered by the agency included Vortac short-range navigation equipment, long-range radar, amplifying equipment for radar on order, communications, microwave relay equipment, airport surveillance radar and instrument landing equipment.

Number of civil aircraft larger than five-place models manufactured during the year totaled an estimated 873 as compared with 700 in 1956. Value of shipments of complete aircraft and parts amounted to an estimated $885.4 million compared to $510.5 million.

Four-engine equipment used by the scheduled airlines increased from a total of 861 in 1956 to 949 last year, an increase of 10%. Number of two-engine transport aircraft, however, decreased 2%, from 848 to 830. Last year, the airlines were operating an estimated 1,809 transports compared to 1,735 in 1956.

Volume of airman certificates climbed substantially in all categories of flying, with the number of commercial pilots showing a 95% increase. Student pilot certificates rose 78%, from 45,036 in 1956 to 80,290 in 1957. Private pilots were up 48%; airline transport pilots 46%, and mechanics certificates 29%. Landing and takeoffs reported by CAA towers during the year totaled 25.3 million compared to 22 million in 1956, a 15% increase. Fix postings were 30.4 million in 1957 compared to 25 million in 1956.

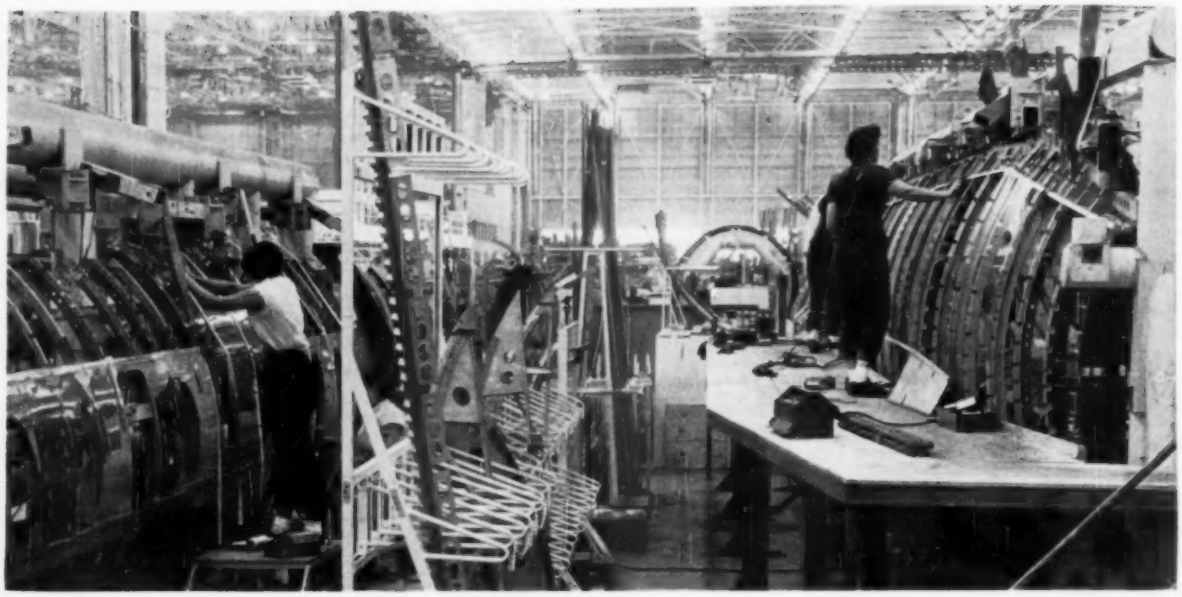
The CAA reported an 8% increase in the number of domestic and foreign passengers handled. Last year, U.S. scheduled airlines carried an estimated 49 million passengers, of which four million were foreign and overseas.

Total passenger-miles for all categories of scheduled travel reached 31.3 billion, a 14% increase over 1956. Revenue plane-miles in domestic operations were up 15% to 790 million last year compared to 687 million in 1956. In international operations, revenue plane-miles climbed 6% to 155 million from a 1956 figure of 146.9 million.

Domestic express and freight ton-miles rose 20% in 1957 over the previous year and 11% in the foreign and overseas field.

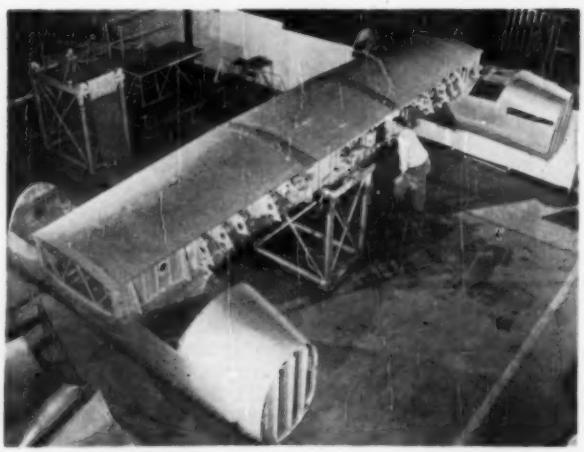
Correction

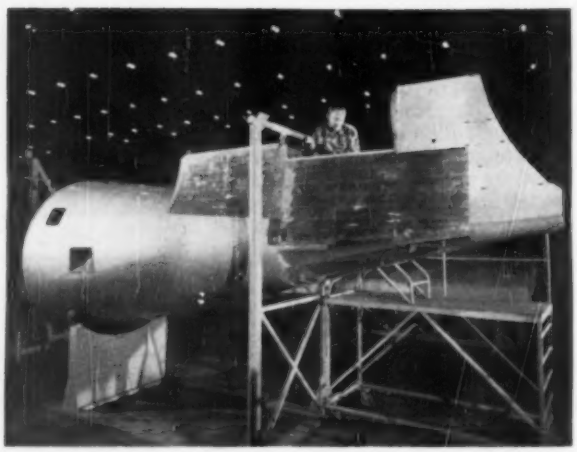
Washington—In reporting airline income and expenses for the third quarter of 1957 (AW Dec. 23, p. 34), Aviation Week inadvertently listed American Airlines as having received $11,111 in federal subsidy payments during the period. Actually American has not received subsidy payments from the federal government for a number of years. The figure listed as subsidy payments should have referred to American's incidental revenue for the third quarter. Aviation Week regrets the error.



Rollout Near for Fairchild's F-27

Fairchild Aircraft Division has scheduled rollout of its first F-27 Friendship transport late this month, with first flight expected in February. First of the turboprop planes will go to West Coast Airlines. Production rate of at least five units a month is planned, with capacity for 10 if orders warrant. Pictured at Hagerstown, Md., plant are (top) side panels on production line; (center) completed center fuselage section; (bottom left) center wing section with engine nacelle shells mounted on it; (bottom right) tail section under construction. Fairchild is building the twin-engined F-27 under license from Fokker. Civil Aeronautics Administration has given the Dutch firm a type certificate for the plane.





Airlines Rap U.S. Stand in French Talks

Washington—Negotiations for a new air transport agreement between the U.S. and France are forcing airlines and the State Department farther apart over administration of U.S. civil air transport policy.

Some of the more outspoken airline representatives in Washington say they already have abandoned hope that the State Department "will accept its responsibilities as guardians of U.S. air rights as intended by Congress." They predict that, if the department continues its present attitude toward American flag carriers, Congress will take action to limit State's negotiating powers during the coming session.

The airlines claim that, from the manner in which negotiations have been conducted, there is little doubt that France will be given a polar route to Los Angeles.

Concession Asked

It was apparent during the course of the talks, airlines said, that the State Department had hoped to gain some concessions that were not too important to France as a trade to justify the award of a polar route to the French.

The French, however, were not willing to trade. They said it was a matter of principle—that France should have the right to fly to every U.S. city from which American flag carriers fly to France. This is where the situation stood when talks ended before Christmas.

The industry feels the State Department will do one of three things between now and the time discussions resume:

- **Attempt to convince** the Civil Aeronautics Board to take a stronger stand and perhaps recommend an outright award of Los Angeles to France to soften the expected protest against the department.
- **Talk the French** into trading air concessions for Los Angeles, thereby justifying the award in the eyes of Congress and the public.
- **Make an outright award** of Los Angeles if all else fails and run the risk of spurring congressional action.

French Stand

The controversy began last September when Pan American World Airways prepared to inaugurate polar service from the West Coast to Paris. A few days before the first flight was scheduled to depart, the French told U.S. authorities that the current U.S.-French bilateral did not authorize a polar route and hinted that Pan American might not be permitted to land.

Both State Department and industry leaders said there was no merit in France's contention, but the Department did agree to discuss a polar route for France, providing the French would permit Pan American and Trans World Airlines, which began service later, to land in France. The temporary authority was granted.

The U.S. based its right to fly the polar route on the language of the bilateral which says U.S. carriers are permitted to fly from the U.S. (no specified points) to specified points in France. The same agreement says French flag carriers can fly from France to specified points in the U.S.

Arbitration Favored

At the outset, industry representatives favored taking the issue to arbitration. They argued that, to get an arbitration clause in an agreement, the U.S. often has to make concessions and, since airlines must pay a price for the clause, then they should take advantage of it when the opportunity arises.

The arbitration clause calls for each country to appoint a neutral country to represent it. The two countries appointed then agree upon a third country to join in the negotiations.

Airlines said the State Department did not favor arbitration on the grounds that it would be difficult for the U.S. to appoint a country that would represent its interests since most foreign countries do not fully agree with U.S. civil aviation policy.

The industry disagreed and pointed out that any country scheduled for upcoming bilateral talks would represent U.S. interests well since, if it did not, it would hurt its chances of negotiating a favorable agreement. The State Department agreed, airlines said, but still remained cool toward the idea.

CAB Recommendation

Before the talks got under way, the State Department notified CAB that no foreign policy or political matters were involved, that the decision would be based strictly on airline economics, and it was asked for its recommendations. The CAB promptly recommended no additional routes for France, but it later changed its stand and indicated it might be better to give France Los Angeles and receive in return additional concessions for U.S. carriers.

American flag carriers, however, said they wanted no additional concessions and that, therefore, there was no need to give additional concessions and thus, there was no need to give additional routes to France.

To back their stand and to assist the State Department in bargaining, airlines were asked by the department to prepare traffic and economic figures pertaining to the exchange of routes between the two countries. Airlines contend they complied with the request at the cost of thousands of dollars, including $16,000 in overtime pay alone. The resulting data, they say, was not used by the State Department to strengthen its bargaining position.

Basis of Negotiation

At the beginning of the negotiations, France said it was not interested in talking about figures or past route exchanges, according to the airlines, but only about the present or future. They admitted to the State Department that their claim to a polar route had no merit as such, airlines said, but argued that, if TWA and PAA were going to fly the polar route to Paris, then they felt a similar route must be given to France on a reciprocal basis. It was on that principle—that the French should have the right to fly to every U.S. point from which American flag carriers fly to France—that they wanted to negotiate.

During the negotiations, airlines said they were told several times by State Department that the French negotiators had obtained prior cabinet approval to denounce the present bilateral if the U.S. was not receptive to French requests for reciprocal rights, or at least Los Angeles.

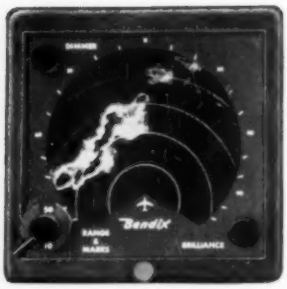
They added that, at the close of the talks, French negotiators indicated they would return to France to confer with their government but, if the U.S. insisted upon obtaining additional concessions in trade for Los Angeles, they might recommend to the cabinet that France denounce the present agreement.

U.S.-French Revenues

"From this," one spokesman said, "it would appear that the threat to denounce the agreement might have been prompted from sources other than the French."

Industry representatives said they believed France would not actually favor withdrawal from the present agreement because it would have more of an adverse economic effect on French carriers than on the U.S. airlines. They pointed out that 25% of Air France's total revenues are derived from its U.S. routes, while only 5% of American flag carriers' international revenues are derived from their routes to France. In actual dollars, however, U.S. carriers receive more than Air France from the exchange.

One reason why talks with the French may be considered delicate is



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that bitter criticism has been leveled at the State Department at least three times in the past over the signing of air agreements.

The first was with Germany in 1955; the next two with the Dutch and Australians last year.

Change in Tactics

As a result of the bitter protests over the German and Dutch agreements, airlines say they noticed a change in tactics by the State Department. During talks with the Australians, the State Department obtained a number of concessions from that government in exchange for a route across the U. S. and on to London, giving Australia a round-the-world route.

The route across the U. S. was a very valuable piece of property, airlines said, but concessions received in return—such as a route to Australia via the South Pole and traffic rights between Australia and other countries which depend upon approval of the other countries—have little or no value to U. S. carriers or the U. S.

They also charge that these concessions were obtained only as an effort to justify giving a valuable route to Australia and represented little sacrifice on the part of the Australians.

First Alitalia DC-7C Will Go Into Service

Milan, Italy—First of six DC-7Cs on order by Alitalia will begin Rome-Paris-New York service this month. The DC-7Cs will gradually be brought in to work the company's North Atlantic luxury flights, combining with eight DC-6Bs flying tourist.

Alitalia capital is expected to be at least doubled in 1958, through either government subsidy or private investments or both. A technical commission has been studying the Caravelle, Vickers Vanguard, Convair 880, Lockheed Electra, Boeing 707 and Douglas DC-8. The commission's report is due this month.

Alitalia's projected transport lineup—beyond the DC-7C and 6B—assigns three DC-6s to Oriental and middle-distance Mediterranean flights, with six Convairs—the 340 and 440—flying Mediterranean and domestic runs. The Viscount 785 will service north central Europe, the number of this aircraft to be increased to 10. Eleven DC-3s will work domestic routes.

Intensive crew training, temporarily reducing carrier capacity, is under way. Courses include new personnel instruction, plus specialized training in the DC-6 and 7, the Viscount, the Convair 340 and 440 and the DC-3. Twenty-five crews are expected to be working by spring.

Bristol, Hawker Siddeley Propose Joint Effort to Build BEA Jet

London—Government efforts to force amalgamation in the British aircraft industry by means of the order for a new British European Airways short to medium-range jet airliner have succeeded.

Bristol Aeroplane Co. and the Hawker Siddeley group have announced that a joint proposal for building the new three-engined aircraft was submitted to the Ministry of Supply, which will place the order on behalf of the state-owned airline.

Private Financing

The government has insisted that the new aircraft be privately financed and that firms interested in the contract pool their resources.

"Both the Minister of Supply and I feel that a policy of merged effort should be encouraged and we shall exert whatever influence we can in this direction in the placing of future orders," Minister of Aviation Harold Watkinson states flatly.

Final decision on the new 575-mph. aircraft, intended to carry up to 99 passengers over a 1,000-mi. range, has been postponed for months, first by technical considerations of whether it should be powered by three or four engines and then by government efforts to use the contract to bring about the desired consolidation.

Originally, four firms submitted separate designs. These were Vickers, Avro, Bristol and de Havilland. Vickers dropped out after receiving the contract for the new V.C. 10 jet airliner for British Overseas Airways Corp. Like the new Vickers Vanguard turboprop, the V.C. 10 is company-financed.

Early Choices

Early technical evaluation favored the Bristol and de Havilland proposals but Avro re-entered the picture when its parent organization, the Hawker Siddeley group, became the first to offer private financing.

Neither Bristol nor Hawker Siddeley have said whether the joint proposal may also indicate that a complete merger is contemplated.

De Havilland, regarded for a time as most likely to receive the contract, meanwhile has submitted to the Ministry a proposal to build the BEA airliner as a private venture with Rolls-Royce, manufacturer of the engines specified on the de Havilland proposal. This proposition, however, does not go as far along the road toward a definite amalgamation as the government seems to want.

In addition, Rolls-Royce may be blocked from going too far with de Havilland since the Bristol proposal also is offered with Rolls-Royce powerplants. These are Rolls-Royce RB-141 bypass engines, a smaller version of the Conway developing 12,000 lb. thrust. Bristol's own Olympus powerplant is another possibility.

Combining technical facilities with Hawker Siddeley also overcomes what had appeared to be a major disadvantage for Bristol—lack of big jet experience.

De Havilland's background in building the Comet was a strong factor in the Hatfield firm's favor. But Avro's experience with the Olympus-powered Vulcan could overcome that edge. Avro also was well along with design of a supersonic jet bomber when the government canceled the contact.

BEA recently placed an order for Comet 4B jet airliners as an interim aircraft until the new jets become available in 1963-64.

It is understood that de Havilland has offered a "buy back" agreement on these six Comets to make a more attractive financial proposition of its proposed new jet.

Cutback Cushion

Britain's aircraft firms regard the BEA jet specification as a choice plum at a time when military aircraft orders are being cut back.

A survey by one of the firms concerned indicates a possible market for 1,000 such aircraft by 1965.

Although recent press reports place the likely BEA order at 20 aircraft, original BEA requirements called for only 12.

It has been estimated by one of the firms involved that private development of such an aircraft may cost about $56 million. In view of the small number of aircraft sought by BEA, it is no surprise in the industry that firms involved may want to spread the financing.

Bristol's most recent balance sheet indicates capital, reserves and surplus of nearly $45 million while the Hawker Siddeley group has capital and reserves of over $157 million. Both Bristol and Hawker Siddeley have substantial overseas interests, including the Hawker Siddeley group's extensive Canadian holdings.

According to Sir Frank Springs, managing director of the Hawker group, the group's total assets amount to nearly $600 million, of which assets in Canada amount to about $350 million.

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SHORTLINES

► **Capital Airlines** reports a net loss of $1,926,464 for the 11 months ending Nov. 30. For November, the airline reported a net deficit of $757,580.

► **Delta Airlines** estimates it increased its available seat-miles by 18.58% to 2,344,423,000 for the calendar year ending Dec. 31. Delta President C. E. Woolman also predicted that Delta would have carried 2,724,387 passengers—an increase of 12.46%—a distance of 1,399,507,000 passenger-miles.. Passenger load factor for 1957 is estimated at 59.70 as against 60.14 for 1956.

► **International Air Transport Assn.** says the total international airline business settled through the IATA Clearing House in London during the first nine months of 1957 came to $468,251,000, an increase of 32% over the same period of 1956. The interline revenue accounts last year totaled $354,456,000. IATA also announced the admission of Quebecair Inc., Rimouski, Quebec, Canada, to associate membership in the organization. Quebecair, which operates from Montreal to Rimouski and mining and lumber camps north of the Gulf of St. Lawrence, is the third Canadian member of IATA.

► **Northwest Airlines** is cooperating in a nine month test of a new airborne radio telephone service with American Telephone and Telegraph Co. A Northwest Boeing Stratocruiser, No. 704, has a telephone installed in the rear of the passenger cabin with receiving points in Chicago and Detroit. At present, the aircraft must be within a 175 mi. radius of the two points. From there, calls can be routed over the regular ground system to other cities. Calls to the plane must be prepaid, a flat charge of $1.75 being set for the air to ground connection and regular toll charges between ground points.

► **Seaboard & Western Airlines** has received a $4 million military airlift contract extension for the first six months of 1958 from Air Materiel Command for transporting U.S. military dependents between New York International Airport and military bases in England, France and Germany. Seaboard & Western and Sabena Belgian World Airlines have signed a $3 million agreement for Seaboard to provide Lockheed 1049-H Constellation aircraft to be utilized in Sabena's transatlantic service during the May-October 1958 tourist season. The aircraft will be used in the new economy fare service, which is 20% below transatlantic tourist fares.

AIRLINE OBSERVER

► Airline Christmas traffic fell short of predictions for reasons not yet known to the industry. Although forecasted traffic was not expected to break any records because of the mid-week holidays, airlines had established a large volume of extra sections between Dec. 20 and Jan. 5 on the strength of heavy reservation listings accumulated during the early part of December. Weather was generally good, but seat cancellations began to mount as the holidays approached and the anticipated Christmas rush collapsed leaving plenty of empty seats for late shoppers.

► Lockheed Electra turboprop transport was brought to a stop in a 900-ft. distance from touchdown at a landing weight of 91,500 lb. during a recent flight test. Propeller control was in ground-idle position, no reverse pitch was used, and minimum braking was required. Maximum landing weight of the Electra is 95,659 lb.

► Hughes Tool Co. has increased its holdings in Trans World Airlines stock by 12,300 shares, bringing the total holding to 5,181,401 shares, or 77.6% of the outstanding TWA stock. Wall Street observers feel the latest purchase is a move toward consolidating tax returns of both companies to apply TWA's anticipated 1957 loss as a tax credit to the Hughes Tool Co.

► Airline stocks remained virtually stagnant in the post-Christmas market rally that sent Dow Jones averages for 30 industrial stocks from 429.11 to 434.16 with total gains outnumbering losses by 696 to 227. Of the nine domestic airline common stocks listed on the New York Stock Exchange, only three registered fractional gains. Four were unchanged, two declined.

► Western Air Lines is at least breaking even and may soon show a profit on its new Los Angeles-Mexico City service, which began July 15. The airline is operating one first-class nonstop flight in each direction daily and is handling 2,200 passengers per month compared to 1,300 when operations were inaugurated. Using DC-6B equipment, Western is giving the route its top champagne service to battle the tough competition of three Compania Mexicana de Aviacion flights served by a DC-4 making five stops, a DC-6 making two stops and a nonstop DC-7. Western is restricted to one flight daily until June 30, 1959, by the bilateral agreement.

► Robert Six, president of Continental Air Lines, is predicting only a slight improvement in passenger traffic for 1958. Six told Aviation Week that, although the airline anticipates the most productive year in its history with the mid-year introduction of the turboprop Viscount Mark II, "profits for the year 1958 could be nebulous" because of rapidly rising costs. Six based his forecast on the general level of the economy and added that the situation "points up the immediate need of an emergency fare increase if the airlines are to show a profit. . . ."

► Donald Nyrop, Northwest Airlines president, is forecasting a 17% increase in revenues for Northwest in 1958 over 1957. Nyrop estimates that revenue passenger-miles for the carrier increased 10% last year as compared with 1956, and revenues climbed 8% during the same period.

► W. A. Patterson, United Air Lines president, is predicting a traffic gain of 6 to 9% in 1958 over 1957 for the scheduled airline industry but warns that "profit margins will be sharply reduced during the coming year unless fares are readjusted." Patterson foresees an increase of 6 to 9% in revenue passenger-miles for United and an 11 to 14% gain in freight ton-miles.

► American Airlines says its 1957 revenue passenger-mile figure will pass the five billion mark, the first time in history that any airline has passed this total in one year. Number of passengers carried by the airline in 1957 will exceed 8 million.

► International Civil Aviation Organization is forecasting that a total of 100 million passengers will be carried by the world's scheduled airlines in 1958 compared to 87 million handled in 1957. Passengers carried in 1957 represented a 13% increase over 1956.

Outer Space: Fourth Frontier of Freedom

The day approaches when command of space may be essential to our national security

Today, our soldiers and sailors and airmen stand guard on the ramparts of the free world ... but at the same time our civilian and military scientists and engineers are hard at work building our defenses on a new frontier. That frontier is Outer Space. There, someday soon, will lie the power to keep the world free—or enslave it.

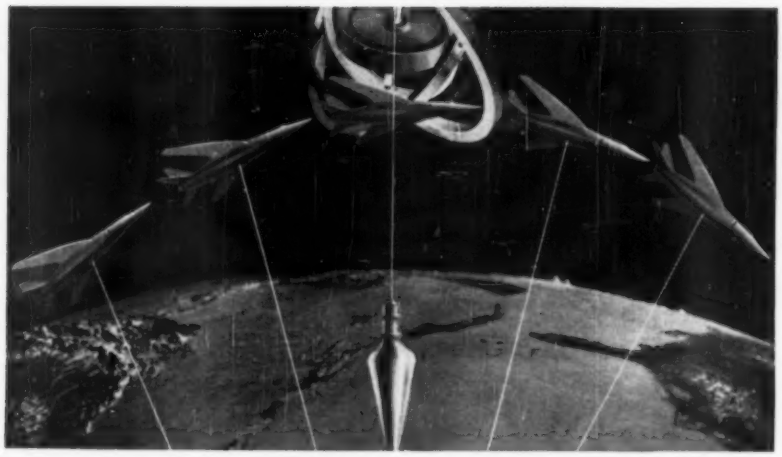
North American Aviation is in the thick of this secret struggle. Its experience with supersonic aircraft and missiles is the greatest in the free world. For several years now this experience has been coming to grips with the toughest challenge of our time—perfecting weapons that will not only span the planet Earth, but also penetrate the airless void around it.

Space Flight Starts Here

First basic essential in the stupendous task of putting an inhabited vehicle into space is an engine with enough propulsive thrust to drive it up through and beyond the atmosphere on which conventional power plants rely. In essence, this is the same problem that NAA's Rocketdyne Division has already solved in its trail-blazing work for our major missile programs—Atlas, Jupiter, Thor, and Redstone.

Naturally, the performance of these large rocket engines is classified. But this much can be said: rocket engines of the necessary power and efficiency to hurl a heavy payload into an earth-circling orbit have been available from NAA's Rocketdyne Division for several years. But these engines are built for specific defense assignments under the direction of the Armed Services. The nation's military capability wisely has not been diverted to the satellite program, which has been handled as a separate scientific project.

Rocketdyne is already at work on novel propulsion systems even more highly specialized for use in true space. It is to a combination of these with the high-thrust chemical rocket engines already being built in quantity that man can look for a vehicle that will actually navigate in space.



INERTIAL NAVIGATION is the new art of guiding an aircraft to a pinpoint – without the help of stars, radio beams, or radar. NAA's Autonetics Division is a world leader in the development of inertial navigation and other automatic flight control systems.

Man Into Space

At North American's Los Angeles Division, the first flying model of a new kind of craft is being readied for flight test. It is a stub-winged bullet of a machine, with a shape reminiscent of the guided missile configurations that have been illustrated in the press in recent years. But it will carry a man.

This is the X-15, powered by liquid-fuel rocket engines immensely more powerful than any airplane engine of the past. It is designed to carry man faster and higher than he has ever flown before.

One day soon, the first X-15 will thrust off and point its needle-nose toward infinity. Up through fast-thinning atmosphere it will rocket, through the inferno of the heat barrier, into the upper altitudes where an unprotected man would disintegrate, on to the moment of weightlessness, the little-known phenomenon that will tell the pilot he is flying through space.

Other bold new concepts now in development at North American include Weapon System 110, an incredibly fast upper-altitude bomber with global range for the Air Force, for which the Los Angeles Division has completed a unique design concept; and the carrier-based A3J, first supersonic attack weapon system for the Navy, which is being produced at the Columbus Division.

These are the planes, based on the experience North American has gained in building more supersonic airplanes than all other companies combined, that will set the pattern for tomorrow. For over twenty years North American has proved its ability to meet the nation's air needs—in quantity, on schedule, and at lowest possible cost.

The Age of Automatic Flight

At this very moment, advanced aircraft —both manned and unmanned—are flying at speeds so far beyond what we now call supersonic that they must be controlled almost entirely by automatic electronic systems. In both types, manned and unmanned, the control system is vital to the success of the mission. NAA's Autonetics Division is a world leader in creating these new automatic systems: flight controls, armament controls, inertial navigation, computers, and other complete control systems for the military and industry.

Of even greater significance, however, is the technique Autonetics has developed for *producing them in quantity*. For these airborne systems are so tiny that what would be a trunkful of standard gear must be miniaturized to fit into a cigar box... so rugged that they can perform with pinpoint precision even in the violent phenomena of supersonic flight through air and space... so reliable, as a result of Autonetics' components testing procedures, that a pilot can trust them with his life—and our security. Autonetics is unique in its ability to mass-produce them with complete reliability.

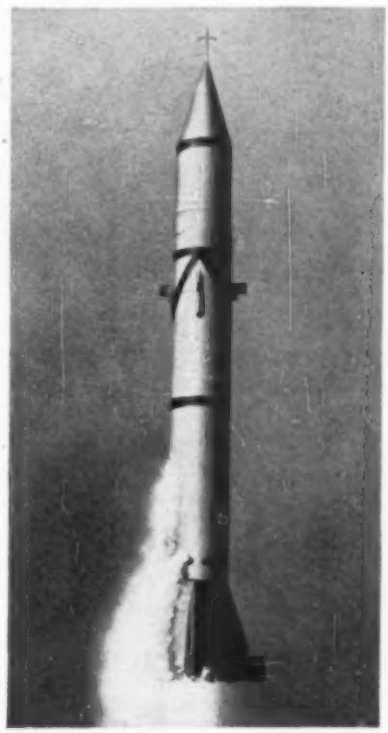
Nuclear Reactors: Power from the Atom

For over ten years the Atomics International Division of North American has been advancing the techniques for deriving practical power from the atom. Two of the most important power concepts under the Atomic Energy Commission's program have been pioneered by the division.

Since last July the Sodium Reactor Experiment in the Santa Susana Mountains near Los Angeles has been supplying electricity on an experimental basis to the homes and factories of the San Fernando Valley. The experiment will supply data for the 75,000 kilowatt station soon to be built for Consumers Public Power District of Nebraska. And on September 17, the Organic Moderated Experiment in Idaho Falls was brought to sustained nuclear fission. It is the basis for two additional proposals for power plants—one in Piqua, Ohio, the other for a Latin American country.

America is sharing the promise of the Peaceful Atom with other lands through AI-built reactors in Japan, Denmark, Germany, and Italy.

Here, in North American, you'll find as potent a combination of scientific, engineering, and production skills as any in American industry. Because the efforts of these men are being spurred by the urgency of national defense, they are constantly forging ahead into new "fields of the future." Much of their work holds immense promise for science and industry.



ROCKET ENGINES – mightiest power packages ever made – are rolling off the production line at NAA's Rocketdyne Division. They launch America's major missiles: Atlas, Thor, Jupiter, Redstone.

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In today's concept of modern weapons our defenses must be many, varied and impregnable. Much has been said about our physical resources — our defense aircraft and our guided missiles — but there is another area — the area of counter measure—a defense system that has been kept as quiet as the operation of the equipment itself.

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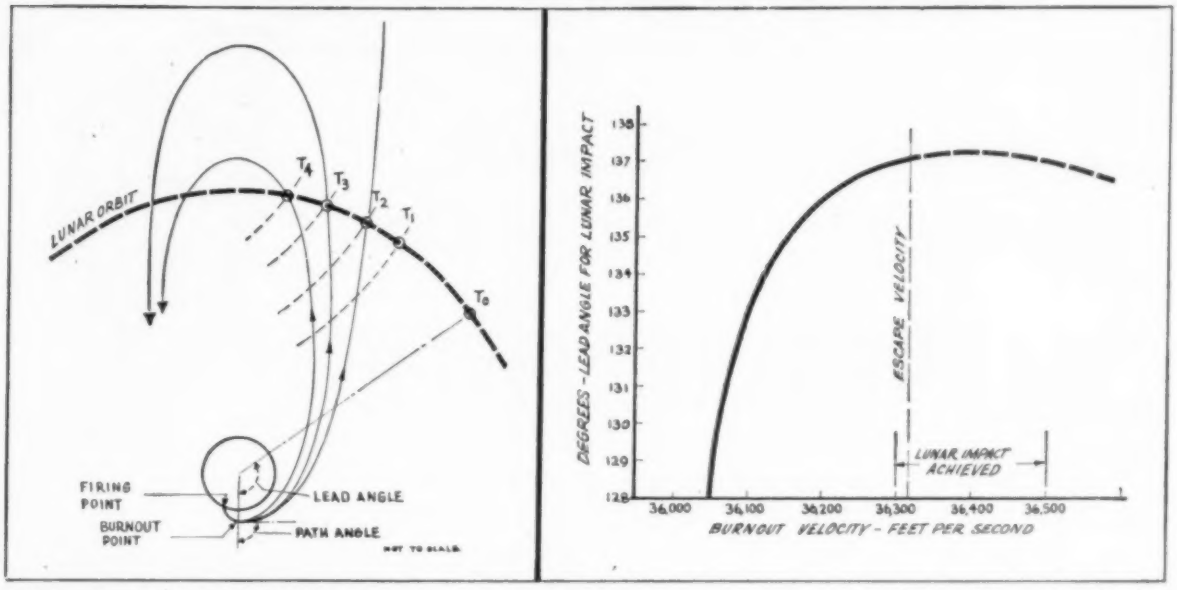


LUNAR motion (Fig. 1, left) is utilized in guidance to impact on the Moon. Slower (inner) trajectories reach lunar distance later than faster (outer) counterparts, but geometric displacement of trajectory crossing points at lunar distance is just compensated by Moon's own motion in orbit. Relationship of lead angle (Fig. 2, right), between Moon and rocket burnout point, to velocity for lunar impact demonstrates tolerance of this parameter to substantial velocity changes. Burnout occurs at 100-mi. altitude. These are examples of the studies Aeronutronics has made in the space field.

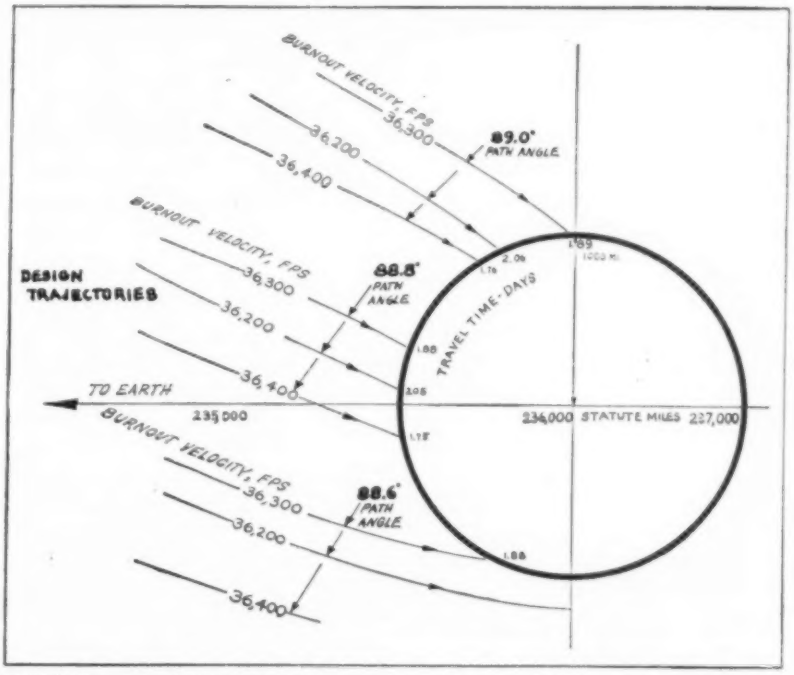
Ford Subsidiary Speeds Space Study

By Irving Stone

Glendale, Calif.—Anticipating the tremendous amount of exacting studies and development required to extend frontiers rapidly in the impending space travel era, Aeronutronic Systems, Inc. is funneling accelerated technical efforts into conception and detail design of devices for these areas:

- **General space research** and Earth satellites.
- **Impacting on the Moon.**
- **Establishing Moon** satellites.
- **Interplanetary travel.**

With about 20% of its technical staff allocated to this work, Aeronutronic Systems Inc., a Ford Motor Co. subsidiary, is prefacing its accelerated studies and development in these categories on the theory that this work will be fundamental to inauguration and success of military operations in space. Except for its completed Farside Phase I out-of-atmosphere research (AW Oct. 28, p. 31), all Aeronutronics' space efforts are supported by company funds.



THESE Moon terminal trajectories demonstrate relative sensitivities of lunar impact to path angle and velocity. Burnout angle is 100 mi. Lead angle is 137 deg. Path angle must be controlled to within 0.2 deg. to insure lunar impact. Path angle is that between local vertical and tangent to trajectory burnout. (Fig. 3.)

Space Research

In the field of "pure" space research, Aeronutronics is investigating problems likely to be encountered in the region

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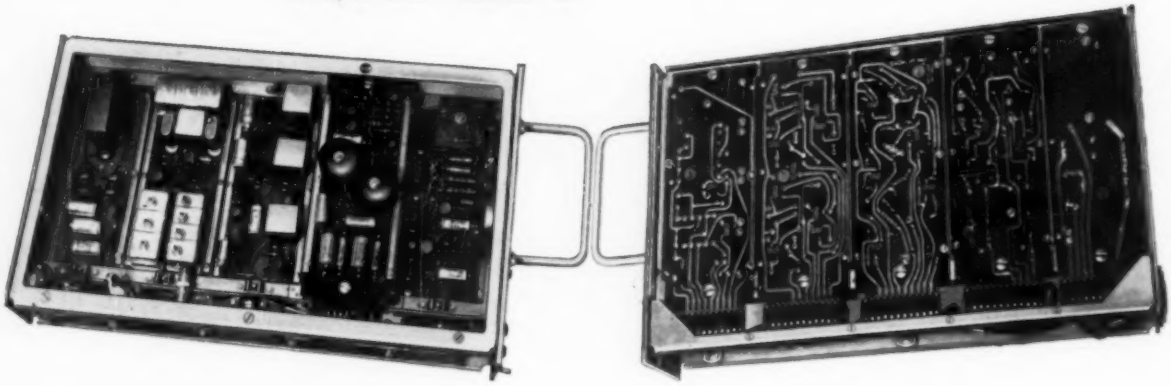

Designed for the jet age, the AVR-200 Marker Receiver meets the demand for lightweight, low power requirement, minimum maintenance. Operating on either DC or AC primary power, the receiver actually needs less power than any of the three lamps it operates.

Among the features are: **Weighs less than 4 pounds • Sectionalized construction for ease of maintenance • Universal power supply (from either 28 VDC or 115 VAC) • No moving parts • Instantly interchangeable with other similar equipment • Printed circuits • Standard short ¼ ATR form factor • Standard industry-coordinated installation wiring.**

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extending 1,000 mi. to several hundred thousand miles from the Earth.

While it includes the Moon area, this field of research is not necessarily concerned with impacting on the Moon. Aeronutronic's philosophy is that for pure space research, high altitude alone is the controlling factor. This can be conducted without guidance, enabling all payload to be used for experimental purposes. While Aeronutronics will not comment on additional Farside studies, AVIATION WEEK has previously reported (AW Dec. 16, p. 26) that a proposal for Farside Phase II already has been made to Air Research and Development Command for environmental studies in vicinity of the Moon.

Special instrumentation is being developed by Aeronutronics to gather information related to:

- **Particle densities.**
- **Meteorite velocities,** sizes and space-time distribution.
- **Magnetic field** intensities of Earth, Moon and Sun.
- **Cosmic ray** and solar radiation intensities.

Complication of this instrumentation exceeds that employed for sounding rockets—units must be tailored to conform to limitation of much smaller payloads. Transmission of information is over much greater distances, so that information handling capacity is much lower. This requires new data links which are lightweight, have narrow bands, low power consumption and involve associated ground receiving equipment incorporating very large antennas.

Equipment Work

Aeronutronics is working in all of these equipment areas. It is developing airborne equipment involved, designing some parts of the ground equipment and building experimental units of other ground-based devices.

In effect an extension of devices developed for Farside Phase I experiments, this instrumentation can be brought into the picture for use in extended space research within six months.

For its satellite studies, same general type instrumentation is being devised. Satellite is a much better platform for making out-of-atmosphere measurements than is the general space research vehicle. For example, measurement of solar radiation can be done over broad spectral ranges with greater accuracy.

Instrumentation used in projects for impacting on the Moon poses difficult problems. One prime consideration is to devise methods to show that impact has actually been achieved. For this purpose, Aeronutronics has devised a series of space and lunar experiments. One of the approaches involves use of an optical system in the vehicle, which determines the distance from the Moon in terms of size of the Moon's image and transmits this information back to Earth over data link. Thus, there could be obtained by optical-to-electronic conversion a picture of the approach to the Moon and at instant before impact on it. Optical system already has been designed and can be built to keep within 2-lb. weight limit, Aeronutronics scientists say.

Moon Impact

Other approaches Aeronutronics is working on, which will require larger payloads, involve chemical and nuclear explosions to signal the impact. Russians also are working in this field to signal Moon impact, AVIATION WEEK has learned.

Aeronutronics has made many studies of trajectories for Moon impact, as well as accuracy required for the guidance system. An interesting solution to the problem has been formulated in which the Moon's motion plays an active role.

Scheme involves only superficial or no velocity control but requires precise control of thrust direction.

Moon moves in roughly circular orbit about the Earth. Rocket is fired from Earth, proceeds along ballistic trajectory, reaching lunar distance at a time determined by initial velocity. Ballistic trajectory is very nearly a conic section, width of which is determined by the initial velocity.

Aeronutronics scientists have worked out a series of these trajectories, in which the distance the Moon moves in its orbit during the differential flight time between two neighboring trajectories is just equal to the spacing of these trajectories (Fig. 1). Thus, if one trajectory achieves lunar impact, so will its neighbors in the trajectory series.

Tolerance to burnout velocity error afforded by this technique is greater than 100 fps. This degree of velocity control can be achieved by careful propellant loading in the final stage or stages, and the payload penalty normally associated with velocity control of a few

Titan Test Stand Layout Completed

Static test stand for Martin Titan intercontinental ballistic missile is shown nearing completion at Martin's Denver plant. Control building in background controls two stands, is connected to stand by concrete tunnels for circuitry, crew access to stand.

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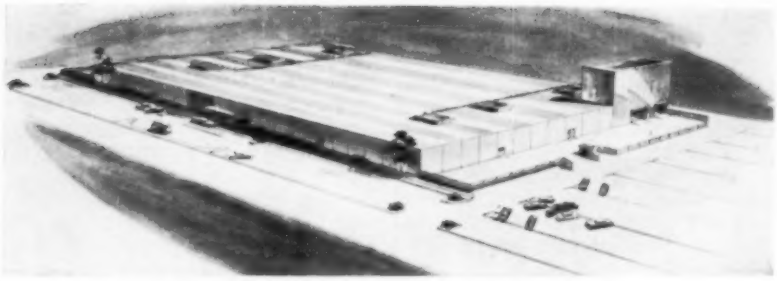

Polaris Development Facility

Lockheed Missile Systems Division is awarding contracts for $3 million Navy Polaris development facility at Sunnyvale, Calif., for planning, engineering, testing and administrative support functions. Unit will enclose 153,000 sq. ft., is to be finished by July, 1958.

feet per second, say 10 or 15 fps., can be avoided.

To take advantage of this technique requires an initial design velocity slightly in excess of escape velocity; therefore, a small payload penalty is paid for the added propulsion required. Representative excess velocity over escape velocity is of the order of about 100 fps. (Fig. 2).

In contrast to tolerance for velocity error, path angle must be controlled to within 0.2 deg. to insure lunar impact (Fig. 3). Path angle is that between local vertical and tangent to trajectory at burnout.

Moon Satellite

Aeronutronics has determined that establishment of a lunar satellite requires that an impulse device, such as a rocket, be used in the vicinity of the Moon to modify the relative velocity between the vehicle and the Moon, so that the vehicle becomes an orbital captive of the Moon. Impulse requirements for a rocket device used for this purpose will vary from 2,000 to 5,000 fps., depending on burnout velocity. With these impulses, satellites can be established in the region of a few lunar diameters from the Moon.

In this phase of study, Aeronutronics scientists are actively investigating all aspects of satellite establishment, including requirements for propulsion, guidance, communication and trajectories, to optimize payload in the orbit and useful life.

Aeronutronics scientists have given general consideration to the problem of reaching Mars and Venus, premised on utilizing many of the techniques and equipment involved in lunar studies.

Because, in the relative interplanetary picture, space is big and planets are small, difficult problem is guidance (sensing and control) en route. Control probably will be with a propulsion device. Along the trajectory, successive corrections will be needed to insure arrival in the vicinity of the target. Aeronutronics has assembled a small group of scientists, trained in astronomy and headed by Prof. Samuel Herrick of the University of California, Los Angeles, which is working on the general problems of interplanetary travel and orbital precision requirements.

Powerplant Requirements

Aeronutronics analyses of the various space regimes contemplate use of existing boosters and engines wherever possible, but it is also determining optimum engine requirements to pinpoint what direction engine development should take, weighing penalty of additional performance against other critical factors involved in the experiments.

Both solid and liquid propellant schemes are under investigation by Aeronutronics scientists, since both forms of propulsion have a definite place in multi-stage arrangements.

Generally, for very high performance, liquid propellant propulsive units are considered superior since specific impulses available with liquids today are greater than with solids, and outlook for specific impulses in the next five years also appear greater than is likely to be obtained from solids, Aeronutronics scientists feel.

Additional Facilities

Preparing for its expanded role in the missile and space travel field, Aeronutronics has acquired a new 100-acre site at Newport Beach, Calif. Plans call for establishment, over a period of years, of a multimillion dollar research, development and prototype manufacturing center. In addition to these facilities, Ford Motor Co.'s engineering staff and manufacturing facilities throughout the country will be available to Aeronutronics.

Planning and engineering of the Newport Beach facility is being guided by Nicholas D. Boratynski, Aeronutronics' director of planning. Boratynski, who formerly was associated as vice president with architectural and engineering firm of Pereira & Luckman, has an extensive background in design, en-

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. . . will be interested to know that the design and manufacturing facilities of Wallace O. Leonard, Inc., Pasadena, are now available to firms in the aircraft and missile field whose need is for flight test instruments of outstanding accuracy that must function reliably under extreme environmental conditions. The following force-balance pressure instruments are available with ten turn rotation of a single-turn and a ten turn output potentiometer to minimize telemetering and flight recording errors:

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IN GREATER NEW YORK—Brierley, Davis Company, 332 Springfield Avenue, Summit, N.J. Telephone CRestview 3-7300 or TWX Summit NJ 355.

IN SOUTHERN CALIFORNIA—Control Components Company, 35 North Arroyo Parkway, Pasadena, Calif. Telephone RYan 1-5172 or TWX Pasa Cal 7175.

LEONARD PASADENA

Wallace O. Leonard, Inc.
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gineering and construction of varied facilities, has planned Aeronutronics' Newport Beach complex to fit new operational concepts in industry.

To maintain operational unity of the complex throughout various phases of future growth, pattern of building expansion is established in radial fashion away from administrative center of the complex.

Design of structures is based on modular method of growth. Each building will be able to expand incrementally in at least two directions with complete flexibility of interior arrangement of partitions and utilities. This flexibility will permit management to regroup personnel and laboratory equipment for individual requirements of each project.

Basic structures of the complex will accommodate these activities:

- **Space and weapon systems.**
- **Electronics and computers.**
- **Aerodynamic and propulsion test.** This unit will house a series of aerothermochemical and material laboratories for work in connection with reentry aspect of intercontinental ballistic missiles under development by Air Force. Construction of these laboratories have already begun, will be completed and in operation by April, 1958.
- **Prototype manufacturing.**
- **General offices.**
- **Services and utilities.**
- **Auditorium and library.**

In the weapon system laboratory, layout is specifically designed to emphasize close relationship between experimental development and pure research. In this scheme, the theoretical offices are built, like a "skin," around a "spine" of laboratories. This will insure close and quick liaison between these two activities, which complement each other so closely in advanced technologies.

Quickly Convertible

Plan for the electronic and computers activity is to use this facility as a quickly convertible laboratory-office arrangement. Laboratories are built around a continuous core of utilities, where any system of services, such as air, electricity, water, vacuum, etc., can be easily tapped, or paneled over for usual office or drafting room use.

Aerodynamic and propulsion test facility will provide Aeronutronics' theoretical and experimental laboratories with a complex of propulsion test cells, hypersonic flow facilities for very high Mach numbers with temperature control, and other precise testing installations for materials and propellants. This arrangement will allow quick check of theory and development, promote execution of changes that may be required in development articles.

Prototype manufacturing facilities will combine mockup and manufacturing areas with a galaxy of specialized shops and test areas, such as centrifuge, environmental chambers, calibration room, printed circuitry shops, potting room, plastic shops, quality control, etc. These activities will surround mockup, manufacturing and assembly areas to promote coordination and speed execution of prototype articles. In the manufacturing shop, Aeronutronics will combine the precision techniques which have been developed in Ford Motor Co.'s Tool and Die Division with contemporary missile space techniques.

Lockheed Seeks Work For Nuclear Facility

Lockheed Aircraft's Georgia Division is seeking additional radiation test work for a nuclear research laboratory the company is building for USAF near Dawsonville, Ga. The company has as its aim the design and building of reactors for use as sources of electrical power and heat. Initial runs on a test reactor to be installed at the laboratory will begin in late 1958, with full operations about March, 1959. Present indications are that USAF nuclear-powered aircraft contracts for the laboratory will not require full capacity.

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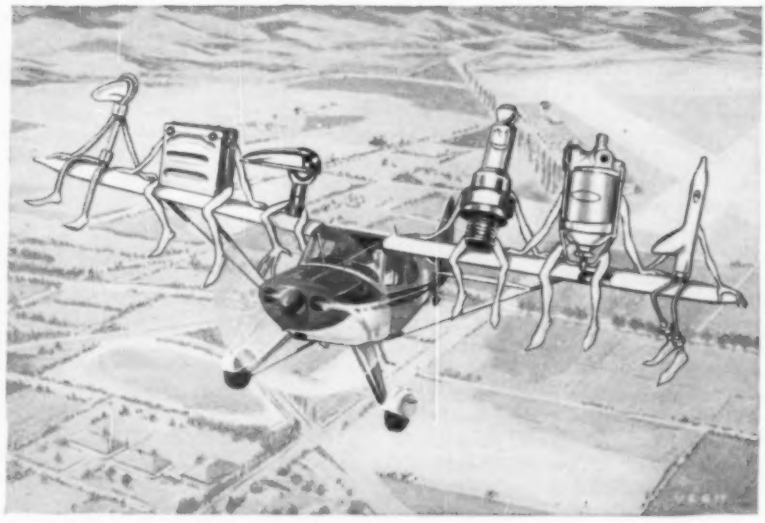

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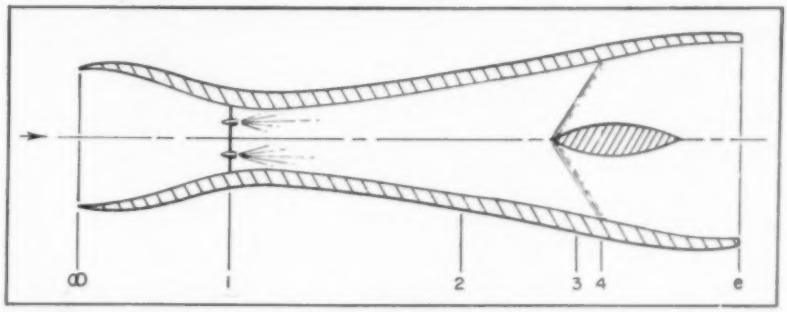
Scientists Study Mach 7 Ramjet Theory

By Robert H. Cushman

Ann Arbor, Mich—Mach 7 ramjets working on the detonation combustion principle may be a further step in the development of air-breathing engines before rocket and other non-air-breathing propulsive schemes completely dominate hypersonic flight.

The possibility for using a standing detonation wave ramjet has been the subject of an exploratory theoretical analysis by basic researchers R. Dunlap, R. L. Brehm and J. A. Nicholls at the University of Michigan's new Aircraft Propulsion Laboratory in the Department of Aeronautical Engineering, here.

Their analysis indicates that if an engine operating on the standing detonation wave principle could be perfected it would show maximum efficiency at hypersonic flight values of Mach 6 and 7. At these Mach numbers it would offer comparable performance to conventional "deflagration" burning ramjets.



STANDING detonation wave "ramjet" mixes fuel with airflow near inlet constriction; when fuel-air mixture hits shockwave front, near-instant explosion follows shock compression.

Several Advantages

The concept embodies a simple duct-like engine flying so fast through the air that it holds an explosive shock wave stabilized on a wedge running across the middle of its passage.

This could offer several distinct advantages:

- **Means of extending** the speed range of air-breathing missiles to Mach 6-7; since the detonation process occurs at high velocities and total temperatures, more thrust over drag is available.
- **Simplification** of the inlet diffuser section, since the burning occurs at nearly the full flight speed.
- **Shortened** combustion chamber with no need for an ignition device.

Michigan's drawing of its design, taken as a lengthwise slice through the center, showed there was a slight diffusion (sides of duct neck in) at the entrance which meant that there was to be some compression of the flow, necessary to increase the fuel-air mixing efficiency. But there were no complicated shock recovery systems since the flow was not reduced much below its free-stream values and never was meant to become subsonic. There would, however, be some variable geometry in an actual engine, Michigan said.

Fuel was shown admitted near the narrowest portion of the inlet. From there it was meant to mix with the airflow as the duct spread out again so that when the fuel-air mixture hit the shock wave front there would be a near-instantaneous explosion following the shock compression.

Downstream of the shock-detonation further divergence of the duct would act as a supersonic nozzle for extremely high jet exit velocity.

Actually what would happen in the shock wave is that the compression and combustion functions which take up most of the length in ordinary slow-burning air-breathers would be combined in the paper-thin shock wave. The shock serves as a simultaneous compression and temperature rising device which in turn serves to instantaneously ignite the mixture.

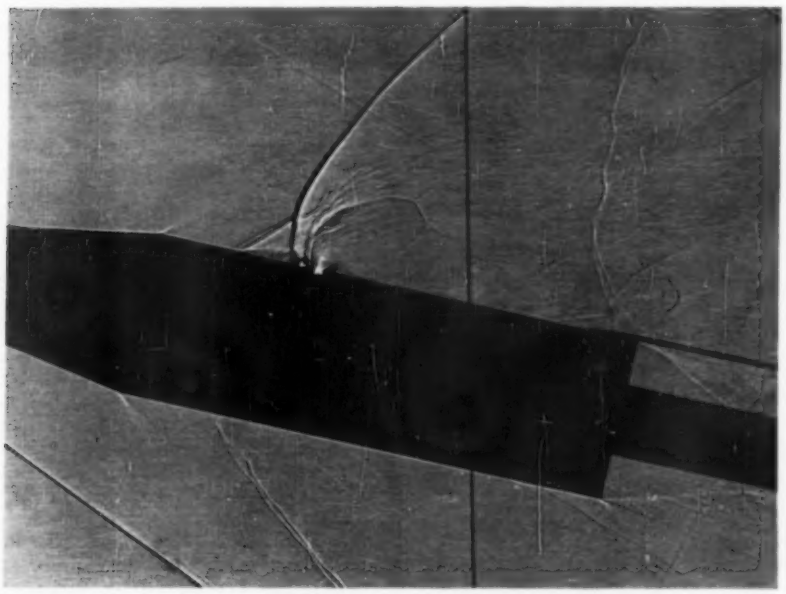
Powerplant Analysis

The Michigan analysis showed that with this sort of powerplant, net thrust would begin to show up at Mach 4 flight speeds and reach a maximum between Mach 6 and 7, then decrease. Since not too much is known yet about the drag of suitable airframe configurations at hypersonic speeds, except that there is evidence that wing-body interferences may possibly be used to permit better lift-drag ratios, it is too early to say what sort of optimum powerplant-airframe Mach number might result.

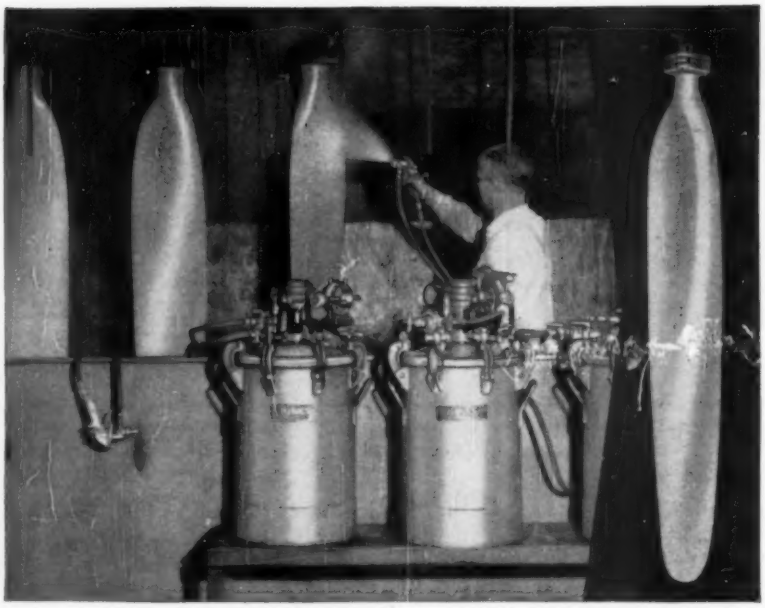
The first problem is simply how to achieve a standing detonation wave. No one, apparently, has been able to achieve such a phenomena for any length of time.

The object of Michigan's present experimentation under USAF Office of Scientific Research contract is to achieve a controlled standing detonation wave.

In some respects the wave is like the wave which travels down a shock tunnel where the combustionable gases are at test, only in this case the gases are moving and the wave is standing



MICHIGAN is also studying use of side jets for high altitude flight control. Here shadowgraph shows control jet creating shock wave as it hits Mach 1.9 tunnel flow.



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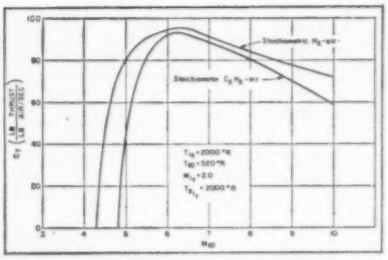


SPECIFIC thrust curves for detonation ramjet show engine is best between Mach 6-7.

still relative to a tunnel or duct.

The next problem, once a standing detonation wave is understood and reproduced under controlled conditions, is to devise a fuel injection system which does not upset the flow upstream of the detonation wave. Dr. Robert Gross, Fairchild Engine Division, Fairchild Aviation Corp., Deer Park, N. Y., pointed out to AVIATION WEEK that the presence of the fuel injection device in the duct entrance would itself cause disturbing shock waves. Michigan skirted this problem in its preliminary analysis by assuming the resulting shock waves would be weak enough to be ignored.

Supersonic Tunnel

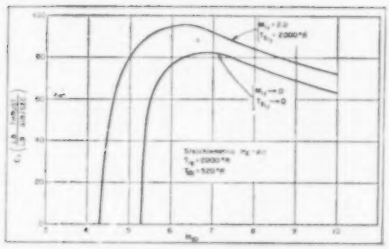
Dr. Gross said he plans to use his new Mach 3.25, 1,200F supersonic combustion tunnel to tackle this and other development problems under a USAF Office of Scientific Research contract.

The third problem is finding the engine and airframe materials to stand up against the aerodynamic heating of hypersonic (over Mach 5) flight. Even at 100,000 ft. altitudes where the air is less dense, equilibrium skin temperatures would be in the order of 1,000F at Mach 7. And though the detonation ramjet would not need any diffusion to speak of compared to a conventional ramjet, the friction between the hypersonic free-stream and the boundary layer would create similar materials surface problems.

The temperature behind the detonation wave resulting from the combined shock temperature and combustion heat release would be intense, possibly giving 9,000F skin temperature.

Missile Potential

It is possible to speculate on the potential of a missile using this sort of powerplant. For example it might make an ideal air-to-air missile to be fired by advanced Dew-Line interceptors: a Mach 7 missile being fired from a Mach 4 fighter. Though probably no match for an intercontinental ballistic missile, except for direct interception under the best of circumstances, a missile using this type of powerplant might have a better combination of



FUEL inlet condition affects performance: higher fuel inlet conditions produce more engine output.

range and maneuverability than pure rocket-propelled missiles, especially solid propellant rocket missiles. This combination might make it suitable for missions which demand continuous evasive action or the interception of other vehicles capable of evasive action.

In the Michigan report it was emphasized that the results were only meant to be sufficiently realistic to compare the hypothesized standing detonation wave engine against idealized versions of contemporary engines.

Nicholls told AVIATION WEEK that their idealized engine was considered to be fueled with either hydrogen or acetylene fuel, but that other fuels might prove better. The air-fuel ratio was stoichiometric; that is, just the correct ratio of fuel was introduced to be completely burnt by the airstream. The effective ignition temperatures were assumed to be 2,000R (1,510F). The detonation velocities were approximately 5,900 fps.

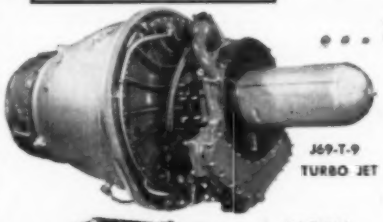
Thrust Shape

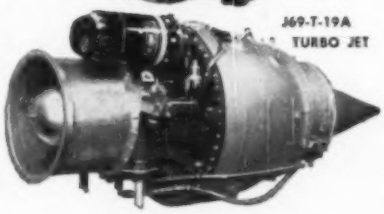
Nicholls explained that the shape of the specific thrust (thrust per airflow) against Mach number curve could be explained by the relationship of the detonation characteristics to the flight Mach number. Below Mach 4 the total energy of the fuel-air mixture was calculated to be insufficient to achieve steady detonation. At slightly higher flight speeds, detonation would occur if the gases were expanded to a very high Mach number. For the very high Mach numbers necessary for detonation, the total pressure loss would be excessive and no thrust would be realized.

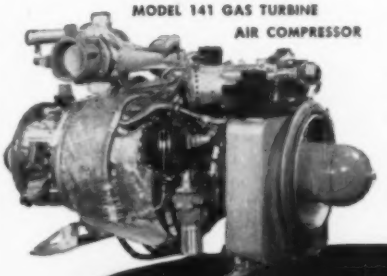
As the flight speed increased, the Mach numbers of detonation were expected to decrease and the specific thrust would begin to increase, Nicholls said. The specific thrust was expected to reach a maximum when the detonation stabilized at its limiting position—the end of the fuel-air mixing section of the engine.

For still higher flight speeds, the Chapman-Jouget (sonic relative velocity for the post shock-detonation flow) oblique wave situation existed at a constant Mach number of detonation, and the ignition temperature and the

... the T-37 Twin Jet Trainer with C. A. E. Turbine Power


J69-T-9 TURBO JET


J69-T-19A TURBO JET


MODEL 141 GAS TURBINE AIR COMPRESSOR

Air Corps flight training routine took a significant step forward recently, when the T-37 twin jet trainer entered its Phase VIII testing at Bainbridge Air Base, Georgia. Twenty hand-picked officers embarked on a course known as PROJECT PALM, with the two-way goal of training for them, and suitability testing for the plane. This new high-performance ship advances the jet phase of fliers' training to an earlier stage in the training schedule, speeding the transition from propeller-driven planes to jets, with gains in both safety and economy. Twin J69-T-9 turbines by C.A.E. provide the power.

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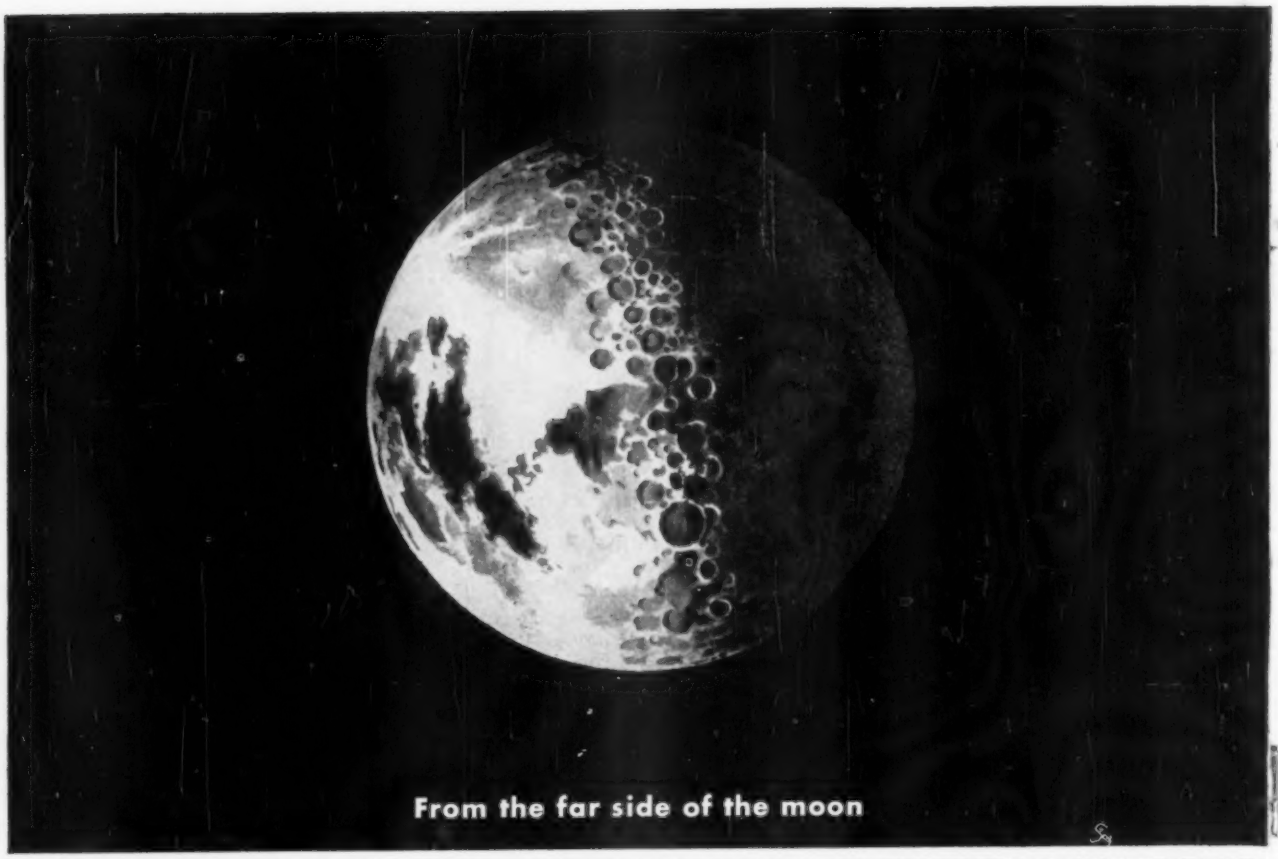
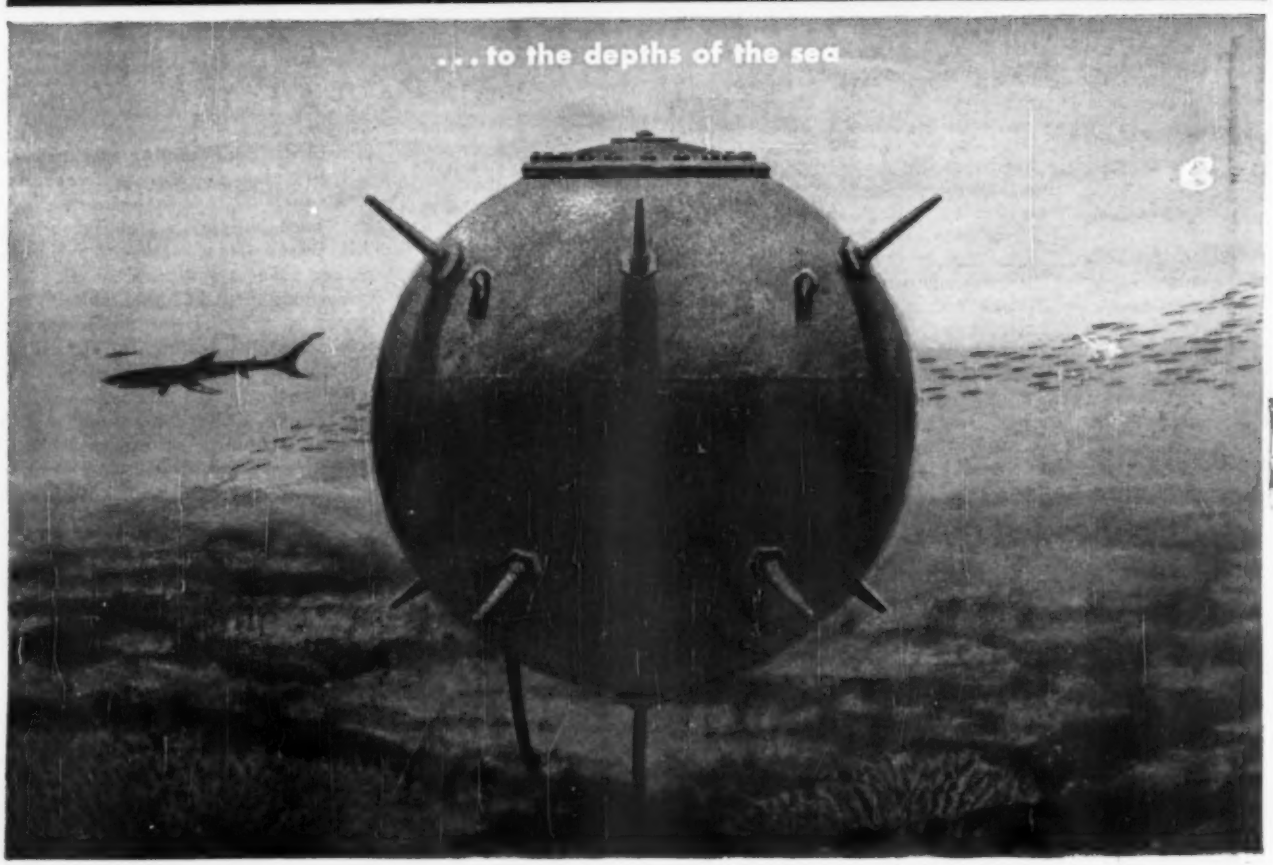

From the far side of the moon


. . . to the depths of the sea

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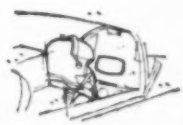

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total pressure ratio across the wave remained constant. At the top end of the engine's Mach spectrum the specific thrust was assumed to have decreased because of the rising total pressure loss associated with the mixing process.

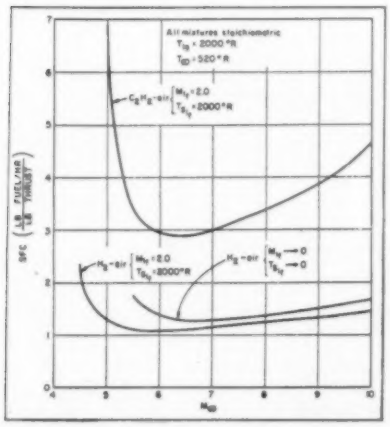
Basic Research Example

Michigan's work on standing detonation waves is an excellent example of the sort of work which can be accomplished in a university environment, according to Don Rogers, now assistant professor in the aeronautical department but who has up until one year ago been associated with California Institute of Technology's Jet Propulsion Laboratory, Ramo-Wooldridge Corp., Aerojet-General and Douglas Aircraft. Rogers said that this research has been another example of how long-range exploratory research, which was too remote in its early stages to continuously interest most commercial firms, was carried on by a university staff to the point where it can now be evaluated for larger concentrations of effort.

Even if the outcome of work on standing detonation waves is not a Mach 7 ramjet, the primary objective of the research, that of just being able to hold a detonation combustion wave still while observing the complex chemical kinetics going on inside could prove a breakthrough in the way of a laboratory tool.

But detonation research also contains an example of how more enlightened industrial firms are competing with universities on their own level. The new research facilities and the basic investigation program on supersonic combustion now commencing at Fairchild Engine Division illustrates this. The continuous-flow Mach 3.25 tunnel will be fed 1,200F flow, and detonation, if achieved (some critics believe twice these velocities and temperatures will be needed), will be observed in the water-cooled 5 x 3 in. test section through quartz crystal windows. Dr. Gross, who heads the section, told AVIATION WEEK that the support he has received from Fairchild management for this basic long-range program has been equal to that he would have expected from a university.

Were it not for the fact that the basic concepts had first been studied in modest ways by universities like Michigan, (and the Applied Physics Laboratory, Johns Hopkins U., Silver Springs, Md., which is doing classified work on detonation), it would seem that it would have been more difficult for Fairchild to sell USAF's Office of Scientific Research (and itself) on such a long-range, neutral-profit program.


All mixtures stoichiometric
T_{t_0} = 2000°R
T_{t_0} = 520°R
C_8H_{18}-air $\begin{bmatrix} M_{t_2}=2.0 \\ T_{t_2}=2000°R \end{bmatrix}$
H_2-air $\begin{bmatrix} M_{t_2}=2.0 \\ T_{t_2}=2000°R \end{bmatrix}$
H_2-air $\begin{bmatrix} M_{t_2}\to 0 \\ T_{t_2}\to 0 \end{bmatrix}$
SFC $\left(\frac{\text{LB FUEL/HR}}{\text{LB THRUST}}\right)$
M_0

BETWEEN Mach 6 and 7 the specific fuel consumption was comparable to idealized conventional ramjets.

Sheet Beryllium Plan Asked by Air Force

Wright-Patterson AFB, Ohio—Brush Beryllium Co., Cleveland, has been awarded a $330,000 USAF contract to develop manufacturing techniques for the production of sheet beryllium.

Because beryllium is light in weight and can retain its strength at temperatures up to 1,500F, the Air Force looks to the metal for wide application in high-speed aircraft and missiles.

Three times stronger than steel but only two-thirds as heavy as aluminum, beryllium is expensive. Estimated installed cost of a beryllium structure is $75 to $100 a pound, compared to $20 to $40 a pound for aluminum.

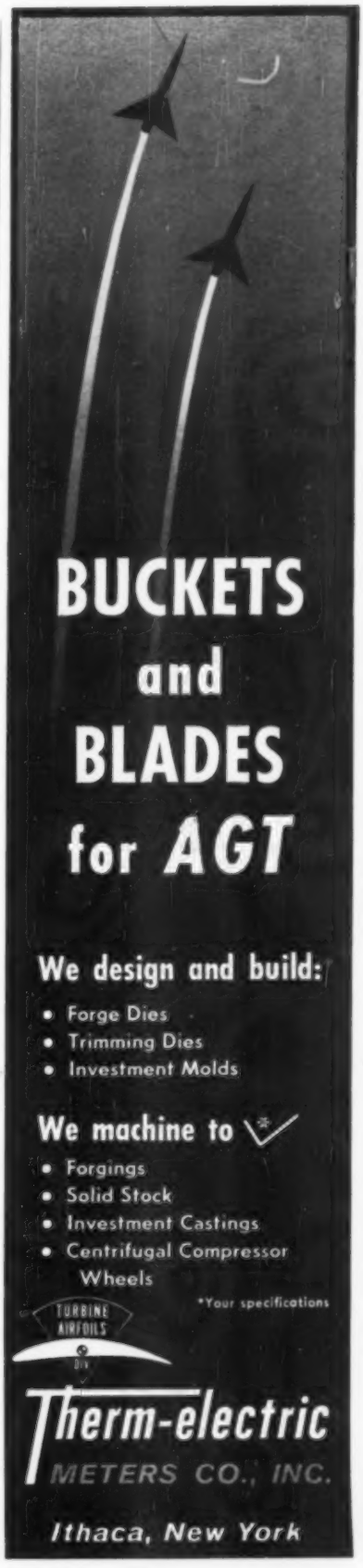
USAF estimates that an all-beryllium Mach 2.5 fighter would weigh 16,000 lb. less than the same plane made of steel. Besides its heat-resistant qualities, the beryllium aircraft would have an estimated 8% superiority in altitude and 16% increase in range.

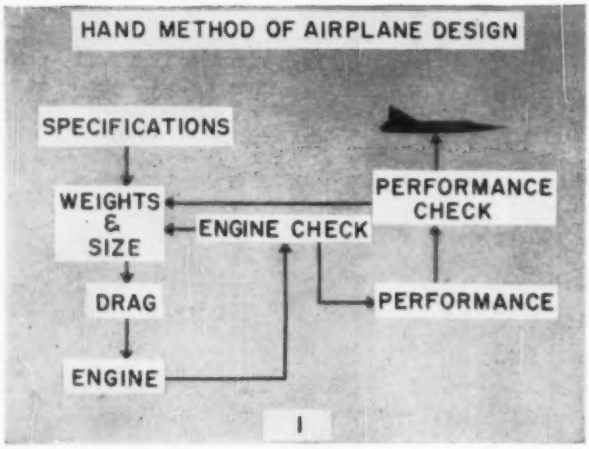
In a transport plane, airframe weight can be cut by 50% as compared with aluminum alloys and effective range increased 40%.

The Brush contract calls for development of rolled sheet beryllium from pressed powder slabs. It was awarded by the Manufacturing Methods Branch of the Air Materiel Command.

Convair Establishes Unit To Procure Subsystems

Convair Fort Worth has established a new department charged with managing procurement of subsystems, which represent almost 50% of Convair's cost in production of B-58 bombers. New department will be headed by Robert Kahn, former manager of material. Fort Worth Division also is merging material and outside production departments into a single department headed by S. E. G. Hillman, former manager of outside production.





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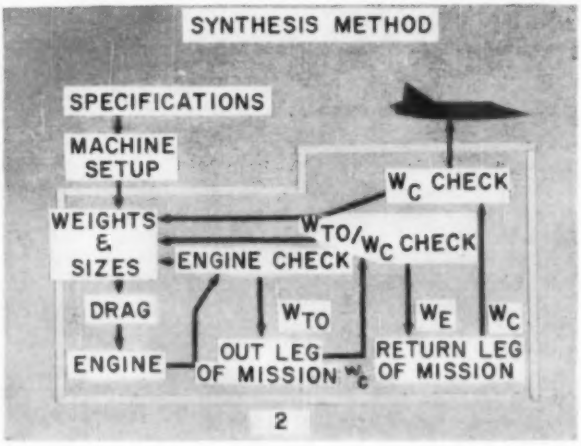


2

How Computers Speed Preliminary Design

By Robert F. Mawhinney*

Synthesization is the term applied to an automatic computing machine process used in the preliminary design of an airplane. By this process the broad preliminary design problem of sizing an airplane to meet a certain set of requirements can be completed in a matter of minutes. The scope of the process covers all of the engineering phases that normally go into a preliminary design: aerodynamics, thermodynamics, layout drawing, weights and structures.

For years we men have been watching the progress of automatic machines in the home such as washing machines and dryers. These machines take the drudgery out of housework. I know that I have been feeling a little neglected because nothing was available to take the drudgery or repetitive operation out of my office work. It appears that finally automatic machines are becoming available to do just that. For those of us engaged in preliminary design and performance evaluation work this synthesis process is one of many such labor saving devices that are currently becoming available.

The process is used to make parameter studies such as wing area studies, tail size studies and so on. Each change of a parameter requires a new design by the process of iteration. Because of the increasing complexity and higher performance requirements of present day aircraft, to do the many necessary parameter studies manually becomes an almost impossible task.

This synthesization process has become an excellent tool in the preliminary design phase of an airplane. By using it the many parameters that can affect the design can be investigated in a very short time. Because of the time saving, parameters can be investigated more thoroughly.

The speed of the digital machines is what makes the process attractive. If we can compare the process to the normal manual means of preliminary design, on the IBM 650 the time for completion is approximately one hour, once all the required information is in the machine.

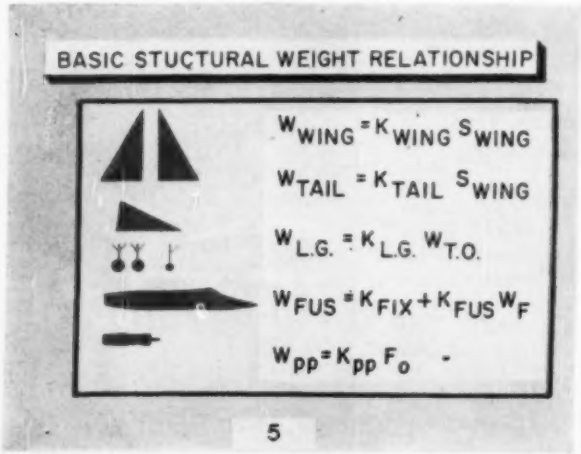
On the newer digital machines the time is on the order of one minute. It takes weeks of engineering effort, depending on the type of airplane, to complete a manual preliminary design.

We all know that nobody gets something for nothing, so let's look at the limitations.

The machine set-up time can run into weeks of effort itself. Unless a parameter study is desired the process may not be used because of the time and economics of the set-up time for just one airplane design.

The engineering data and operations are represented in the machine by equations. These equations necessarily

* Senior Aerodynamic Engineer, Convair Division, General Dynamics Corp.



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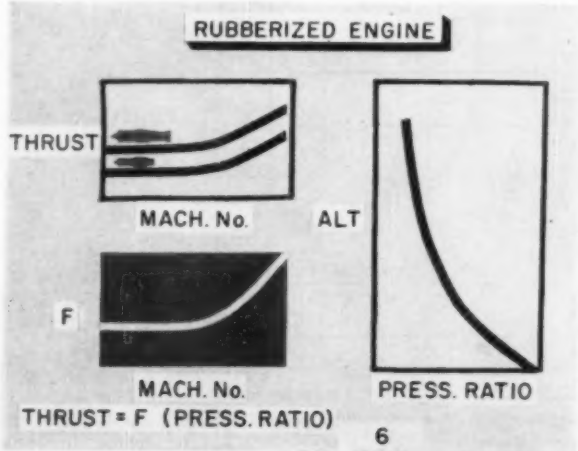

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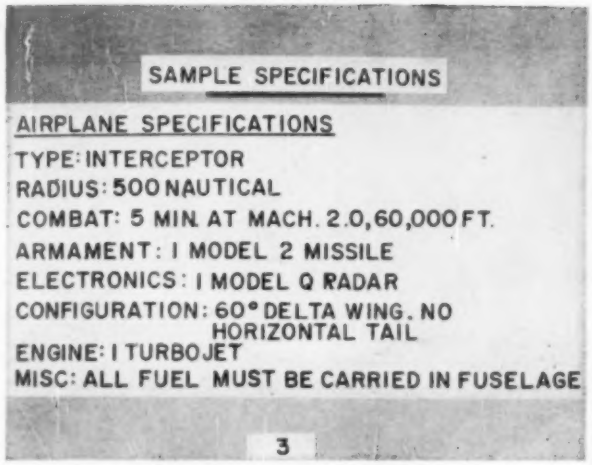
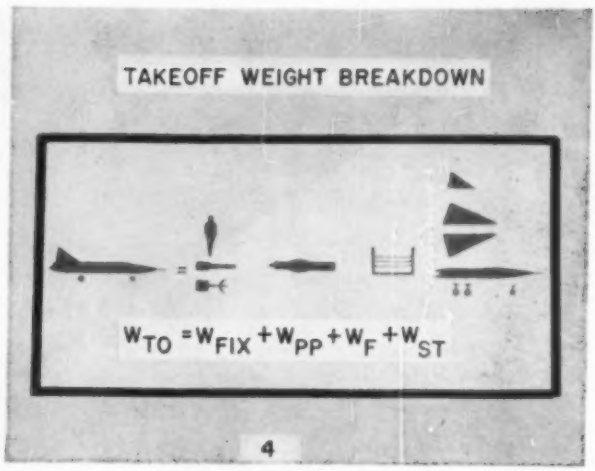

SAMPLE SPECIFICATIONS
AIRPLANE SPECIFICATIONS
TYPE: INTERCEPTOR
RADIUS: 500 NAUTICAL
COMBAT: 5 MIN. AT MACH. 2.0, 60,000 FT.
ARMAMENT: 1 MODEL 2 MISSILE
ELECTRONICS: 1 MODEL Q RADAR
CONFIGURATION: 60° DELTA WING, NO HORIZONTAL TAIL
ENGINE: 1 TURBOJET
MISC: ALL FUEL MUST BE CARRIED IN FUSELAGE
3



only approximate many of the engineering functions. For example, it's pretty difficult to express in equation form the layout drawing function, of finding space and locating different components. The closeness of the approximations depends on the complexity of the equations which directly affects the machine set-up time.

Therefore, there is a trade-off; more accuracy of the equations costs more set-up time. On each problem a human decision must be made as to the machine set-up time required. It can be expected that time will bring more accurate equations with less set-up time, as new methods are evaluated and more experience is gained.

Another point to be brought out here is the fact that the results are only as good as the inputs. This is true for any kind of problem, but the point is that there is no magic inside a digital machine. The inputs are the engineers in the different engineering phases. I don't mean that these engineers are pushed into the front end of the machine to be ground up as fuel for the process. Even though I have heard this suggested, it would be classified as murder. But all of the engineering decisions, choices and data are provided by the engineers in the different phases.

The machine only does the calculating that the engineers tell it to do. It has three functions; 1) it can do arithmetic, 2) it has a memory, and 3) it can make comparative decisions. Other than these functions the electronic brain is pretty stupid compared to the human brain. It has no instinct and it can't think for itself at all.

There are only two areas where it shows an advantage over a human being: 1) it can do arithmetic at a fantastic speed, 2) it has absolutely no aversion to work. I know I would rebel at the repetitive operations it performs. The machine therefore, is only as smart as the engineer who tells it what to do.

The process itself is purely arithmetic because everything is represented in equation form. The only advantage the digital machine provides is its speed; the process could be worked manually.

In the following discussion, I will explain the mechanics of the machine process and some of the more interesting results that can be achieved. The sample design that I will use is much

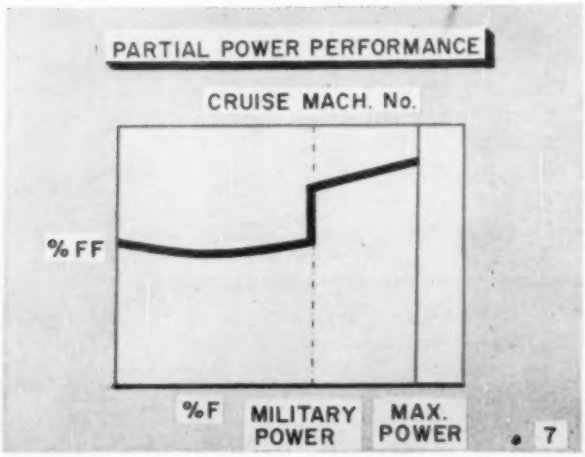
Engineer Describes Rapid Design Process

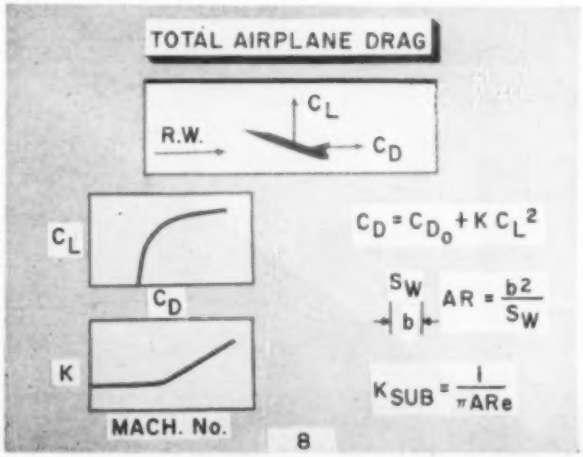
Speed-up of the preliminary design of aircraft through the use of a digital computer is described here by a senior aerodynamic engineer at Convair (San Diego). This comprehensive method considers the aerodynamic, powerplant, weight and structural aspects of design.

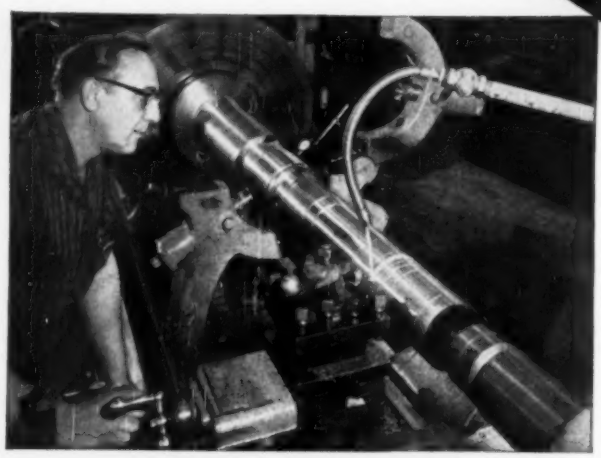
Convair has found that extremely complete studies showing the effect of every possible combination of variables can be made quickly once preliminary design personnel become proficient in programming the computer.

Similar studies and programs are underway in a number of aircraft firms. Aviation Week is publishing this Convair paper for its educational value to those in the industry not familiar with preliminary design work and to give those working in this design phase an opportunity to compare their methods with procedures used elsewhere.

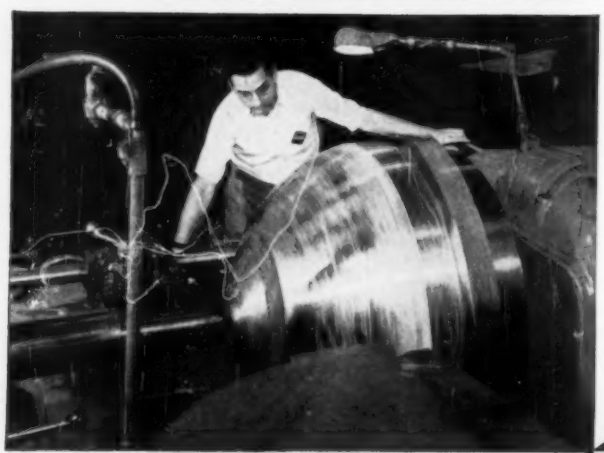
A quick preliminary design method was presented in Aviation Week May 20, page 78; it was devised by Sherman Brunk, another Convair engineer.







Machining a solid shaft from 4340 alloy for compressor of industrial gas turbine used on gas-transmission pipeline.



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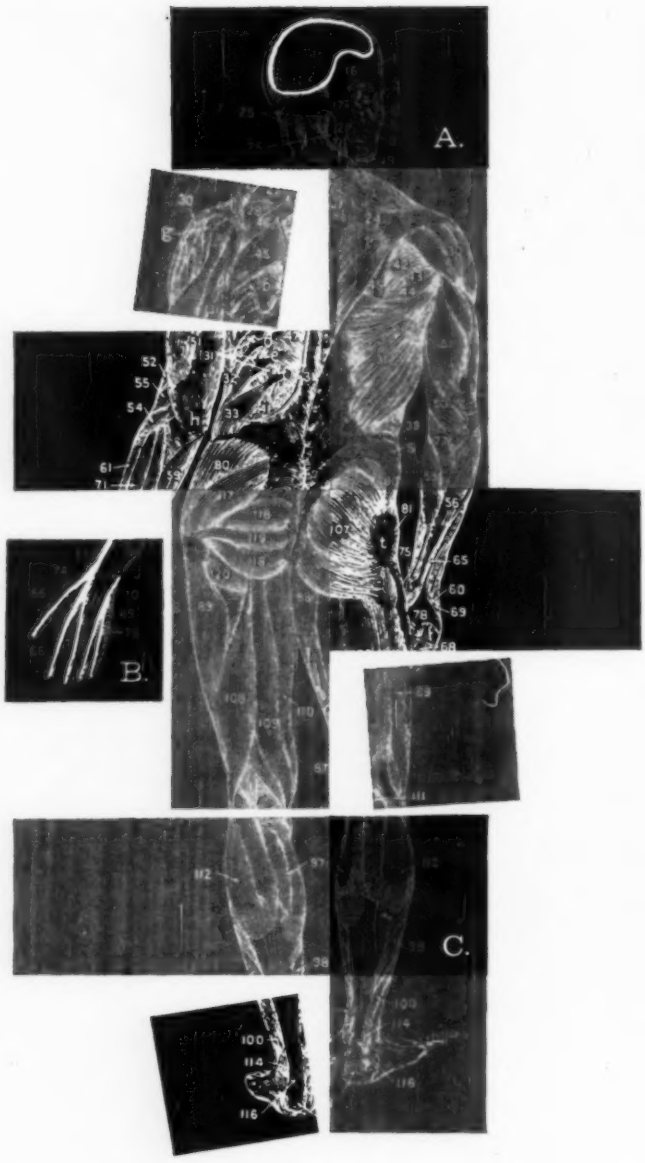

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simpler than any that has been used at Convair and is only useful for explanation purposes. The inclusion of more complication in the details would only prolong the discussion and tend to confuse the explanation of this broad subject.

Preliminary Design Problem

First of all, let us look at the preliminary design problem itself as shown on slide 1. There seems to be no place to start. An airplane cannot be calculated in the normal sense of the word. The engine size depends upon the airplane size but then the airplane size also depends on the engine size. This means that an airplane design results from a balance of all the components of the airplane to do a certain job.

Usually a design is started with an estimate of the weights and sizes of the airplane components. The flow diagram on slide 1 has been described in word form in many of the early texts on airplane design. This flow diagram is used today throughout the aircraft industry and is just as good for modern day aircraft as it was in the days of struts and guy wires. There may be some modifications to the flow diagram depending upon the particular airplane and company practices.

Before any airplane design can be started a set of specifications is required. These specifications are usually furnished in good detail by the customer especially if the customer is a government agency. However, many times specifications must originate within the company itself and sometimes have to be made by the airplane designer.

With the specifications an estimate of the weights and sizes of all the components of the airplane is made. Once this has been done the drag of the airplane can be estimated through the flight regime. The engine is usually designed to meet the high speed condition of the airplane. At the high speed, the engine thrust must at least equal the airplane drag.

Knowing the drag, the engine size can be determined from its thrust requirement and an engine check made to determine if the calculated engine size agrees with the engine that was estimated in the weights and sizes plot. If the engine size does not check, a new weights and sizes estimate must be made and this first loop re-started. When the engine size does finally check, performance of the airplane can be calculated.

The weights and sizes estimate has allowed a certain amount of fuel that can be used in the performance of the airplane. The performance is then calculated with this fuel in an effort to match the specified performance. At the end of the performance calculations, a performance check is made to

see if the calculated performance does check with the specified performance. If the performance does not check, the whole problem must be re-started with revised estimates in the weights and sizes block. When the performance does finally check, the airplane design is completed.

Slide 2 shows the flow diagram for the synthesis method as used in the computing machine. This diagram is very similar to the one we just looked at. However, you will notice that there is an additional block immediately after the specifications called machine set-up. It is here that all the different engineering phases must instruct the machine on how to design the respective parts of the airplane. Also the flow diagram itself must be read into the machines so that the machine can perform the balancing problem of airplane design.

You will also notice that the performance loop has been divided into two loops. The sample design that we will see as an illustration will be an interceptor type of airplane. Therefore, a radius type of mission is required where the airplane must intercept the target at a certain radius from its base, i.e., the range out must equal the range back.

The performance calculations are divided into an out leg and a return leg and the first check is a takeoff weight to combat weight ratio check for the out leg of the mission. The last check is a combat weight check for the return leg. The return leg, in this particular example, is calculated in reverse in order to solve for the combat weight. Performance can usually be calculated either backward or forward but the airplane can only fly forward.

Design Specifications

A brief set of specifications for our sample design is shown on slide 3, which are extremely simple as far as specifications go. Usually in order to design an airplane, specifications extend many pages. The sample design will be very simplified in order to explain the form of the equations used and the philosophy behind this form. Many of the details of the equations have been eliminated since they would only tend to confuse the explanation. These specifications are purely arbitrary and any similarity to a real airplane is purely coincidental.

For the sample design, it is assumed that the engine is "rubberized." Sometimes engine manufacturers have not frozen the size of their future engines. It will be assumed here that the engine make has been chosen but the size of the engine, as well as the size of the airplane, must be determined by preliminary design.

A weight breakdown of our sample airplane is shown in slide 4. In order to allow the airplane to grow and shrink in its preliminary design, the takeoff weight must be broken down as is shown here. The fixed weight, W_{FIX}, is composed of all components that are fixed by the mission requirements.

The pilot, the missile, and the radar set fall into the category and will not grow or shrink with the airplane since they are independent of the airplane's size. A powerplant weight, W_{PP}, will vary with the amount of thrust required from the engine. The fuel weight, W_F, depends on the performance requirements as outlined in the specifications. The structural weight, W_{ST}, includes all of the structural items of the airplane such as wing, fuselage, landing gear. All of these items will vary in weight and size except the fixed weight items.

The structural weight can be broken down still further as shown on slide 5. I would like to emphasize that these expressions are very simplified and are not those that have been used by Convair. However, they serve the purpose of demonstrating the form of the weight expressions. The wing weight is obviously a function of its wing area. The tail weight is also a function of wing area with a stability requirement that the tail area to wing area must remain constant.

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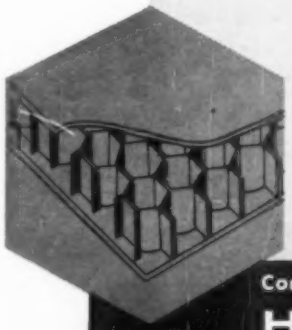

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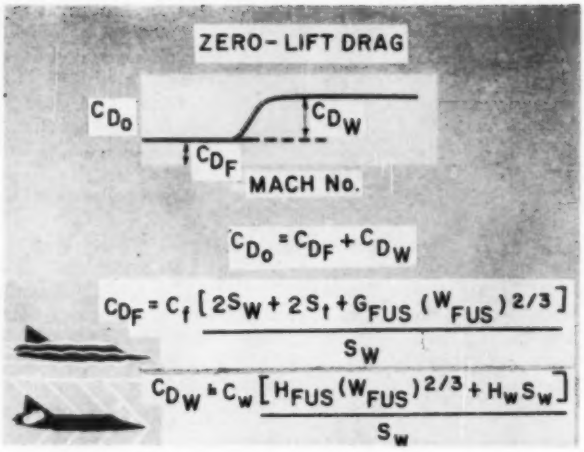
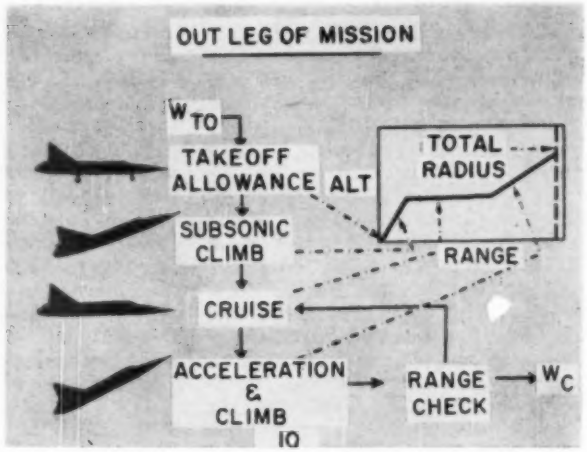




the airplane takeoff weight since it must support the airplane under these conditions. The fuselage weight depends on the fuel weight since it was specified that all fuel must be carried in the fuselage. The powerplant weight is a direct function of the sea level static thrust of the engine. All of the K factors are constants and must be determined by the airplane designer for the particular airplane he is designing. This has been done by the usual procedure of layout drawings and weight estimations for the airplane in question.

These expressions are extremely simple and for any particular airplane design it would be up to the engineer to make them more complex so that a better representation of the airplane would be obtained. These weight equations, for this simple case, also design the sizes of the different components. For a particular component the weight is proportional to the volume. These weight equations allow all of the different components of the airplane to be "rubberized" and therefore grow or shrink as is necessary to meet this specification.

The "rubberized" engine concept is shown on slide 6. The upper left curve demonstrates how the engine thrust and engine size varies. For our particular engine, proportionately more thrust will be obtained from a larger engine. Thrust vs. Mach number curve will have the same shape except that the entire curve will be shifted up for a larger engine.

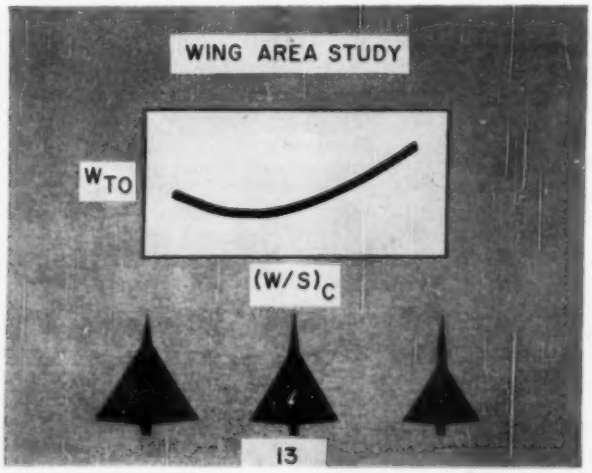
Uses Equations

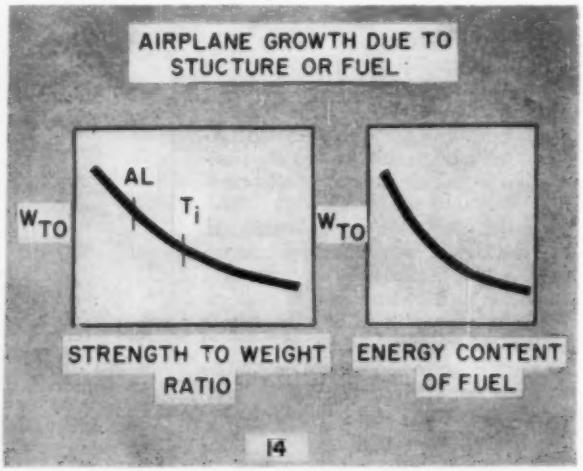
The machine process uses equations through all of the design phases. The maximum thrust is calculated in equation form as a function of Mach number and pressure ratio as shown on slide 6. F* is a function of Mach number and can be represented as such by a polynomial. The pressure ratio is a function of altitude and is given for whatever standard atmosphere is used. For our simplified engine the maximum thrust over the entire flight regime is calculated from these two functions. The fuel flow is represented in exactly the same manner.

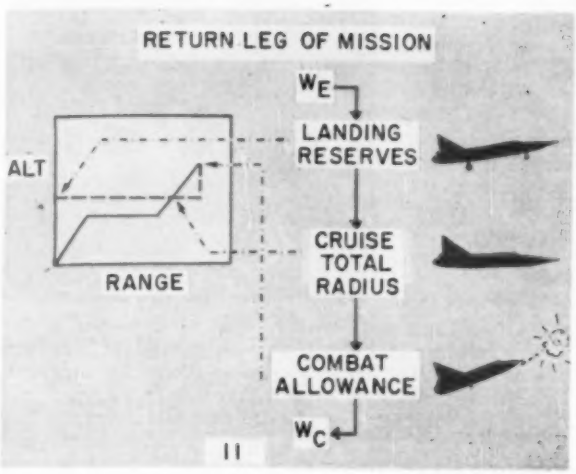
For our interceptor, maximum engine performance is used in most of the mission phases. The only exception is the cruise and the engine performance for the cruise as shown on slide 7. Both the cruise out and the cruise back are accomplished at the same Mach number so that only one partial power curve is required. Again an equation can be fitted to the curve as shown here so that the per cent fuel flow can be determined by whatever per cent of maximum power is required for cruise.

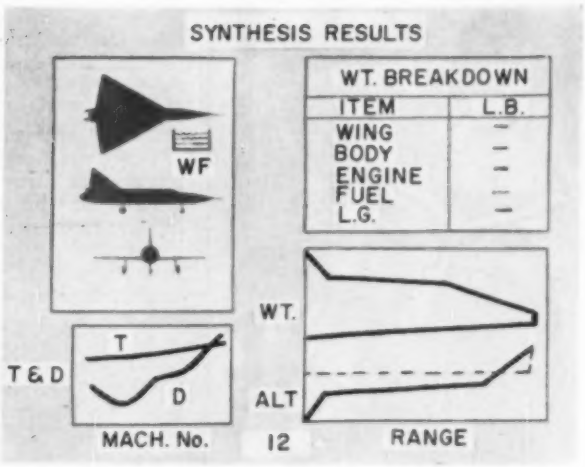
For our simplified case, it is assumed that this curve is independent of altitude. You will notice that the fuel flow increases at military power where the afterburner must be turned on to obtain higher thrust. The maximum power represents 100%F and 100%FF. For an airplane that requires partial power at other Mach numbers this same form of curve would be entered into the machine at the particular Mach number. The cruise of our airplane would occur below military power at the lower fuel flows.

The drag of our sample interceptor is expressed by a simple parabola as shown in slide 8. The drag coefficient is composed of a zero lift drag component and a drag-due-to-lift component. This drag-due-to-lift factor, K, is a function of Mach number as shown in the lower left curve. In the subsonic regime, K can be found by the well known expression $1/\pi AR_e$. K depends upon wing planform in both the sub-









sonic and supersonic regimes and its variation with Mach number can be determined by theoretical, experimental, or any other means available. A polynomial can be written to express K as a function of Mach number.

The zero lift drag is shown on slide 9. For our airplane it is composed of friction drag and wave drag. Wave drag, of course, is zero in the subsonic regime. Both of these drags are calculated by the machine using the expressions as shown. A friction coefficient can be chosen for the Reynolds number of the airplane and the machine can calculate the wetted area in order to find the friction drag.

The wave drag calculation is made in much the same manner. Wave drag coefficient based on frontal area would be given and the machine calculates frontal area in order to find the wave drag. These drag expressions can be made more complex in order to fit the drag estimates of the airplane to be designed. The acceptable degree of simplification on all of these equations is up to the engineer.

The out leg of the mission is shown in slide 10. Starting with the takeoff weight, the out leg consists of takeoff, a subsonic climb to cruise altitude, a subsonic cruise and then an acceleration and climb to combat position. The performance calculations are normally done by the use of equations so that there is nothing new in this part of the synthesis process. Takeoff allowance is a fixed time allowance at a power setting to account for warmup, takeoff and acceleration to climb speed. The subsonic climb and the cruise are calculated by a normal procedure as is the acceleration and climb block.

Total Range

You will notice that there are three range blocks in the out leg of the mission. The range, or total radius of the airplane, has been specified as 500 nautical miles. Therefore, the total range of these three blocks must equal 500 nautical miles. The range of the subsonic climb cannot be modified but the cruise range can.

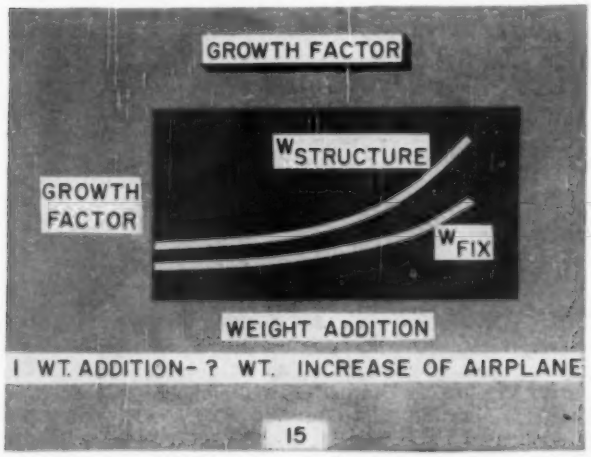
A range check must be made after the acceleration and climb to adjust the cruise. This range check will send the calculation back to the cruise until the total range checks with 500 nautical miles. When the check is made, a combat weight has been calculated and the ratio of takeoff weight to combat weight can be found as a check of the out leg of the mission.

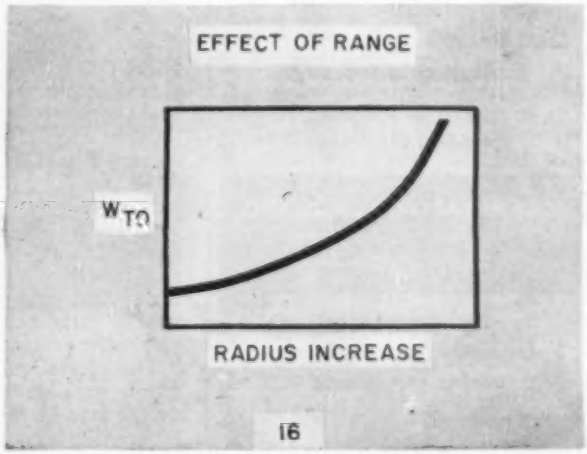
The return leg of the mission is shown on slide 11. You will remember before that I mentioned the return leg is calculated backwards. Starting with the empty weight, W_E, the landing reserves are calculated. These usually consist of a fixed percentage of total airplane fuel.

Next the cruise is calculated over the entire radius of the mission. The combat allowance has been specified as five minutes at Mach 2, 60,000 ft. This would be done at maximum power and allow the interceptor to locate the target, lock on, launch the missile, and escape from the blast area. There is only one cruise block in the return leg so no range loop is required.

The result of the return leg calculation is combat weight. This combat weight constitutes the check of the process as shown on slide 2. You will notice that in the previous discussion we have explained the form of the equations in all of the blocks shown on slide 2.

These equations for the most part have been extremely simple in order to





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clarify the explanation. It is up to the design engineer to derive his own equations for these blocks using the form that has been explained herein. When the last check of our sample design is completed the preliminary design problem is balanced and therefore finished.

When the design balance is accomplished, the type of results that are given by the synthesis process are shown on slide 12. Dimensions of many of the components are given so that they can be drawn to scale. The thrust and drag, in pounds, are given indirectly over the complete flight regime of the airplane. A weight breakdown is also obtained. Many of the weight items are given directly but some must be obtained indirectly by known ratios to the other components.

Complete mission performance is also given; the mission profile along with a weight vs. range plot. All of these results represent the absolute values that result from the balance of the airplane to meet the specified requirements.

Optimum Design

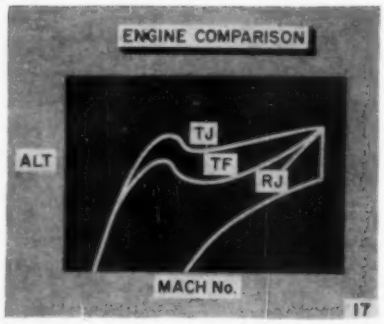
This machine process is very useful in making parameter studies that are necessary to obtain an optimum design. One such parameter study is shown on slide 13 and is actually a wing area study but is plotted as takeoff weight vs. combat wing loading. The larger wing is at the left side of the curve. In this particular study we wanted to optimize the airplane to have the lowest takeoff weight.

Since airplane costs are roughly proportional to the weight of the airplane, the minimum point on this curve represents the lowest cost airplane to meet the requirements. This may not always be the optimum criteria to use. For an interceptor airplane it may be highly desirable to reach the combat condition in the shortest possible time. The plot on slide 13 would then be time to combat vs. combat wing loading in order to choose the optimum design.

Changing any parameter, such as wing area, affects all other components of the airplane and the only way to make a true parameter study is to redesign the airplane for each parameter change. Every point on the curve on slide 13 represents a re-designed airplane with the effect of the wing area change on all different engineering phases included.

The re-design is a relatively simple process with this method because it represents only an input change and the machine proceeds through the laborious re-design itself. To duplicate such a study by hand would cost a prohibitive amount of time.

Two more parameter studies are shown on slide 14. The strength to weight ratio of different structures can be investigated as a function of take-



off weight. Here it is shown as the strength to weight ratio of structural material increases the takeoff weight of the airplane decreases.

Two typically structural materials are shown on this curve, aluminum and titanium. To fully evaluate any type of structure, a parameter study as shown here would have to be made. The energy contained in the fuel also has a large effect on the takeoff weight of the airplane. By changing to a higher energy fuel than that currently used, the takeoff weight would be reduced. Every point on both of these curves represents a re-designed airplane as do the points on the wing area study just discussed.

The discussion of the effect of structure on the overall weight of the airplane brings about a discussion of growth factor. Growth factor has been defined as the overall airplane weight increase divided by the causing weight addition. Actually growth factor on an airplane varies with the weight addition itself. By adding 1 lb. of weight the airplane may grow 5 lb., but by adding 100 lb. of weight the airplane may grow 600 lb.

The growth factor, therefore, increases as the weight addition increases. As shown on slide 15 there are two different kinds of growth factor; a growth factor for fixed weight, "FIX, and a growth factor for structural weight, "STRUCTURE.

By adding a fixed weight to the airplane, such as another missile, the airplane must grow in order to carry this additional weight throughout the required mission. By adding an increase in wing weight to the airplane the airplane must grow in order to carry this increased wing weight, however, the wing must grow a little to support the increased airplane weight and therefore the wing weight will increase a little more. Therefore, a structure weight growth factor is higher than a fixed weight growth factor. Both growth factors increase with weight addition.

Another type of study is shown on slide 16. By increasing the radius of the mission the takeoff weight of the airplane will increase. As you see, at the higher values of radius the takeoff weight increases rapidly. There is some radius beyond which the airplane could not

operate no matter how large it is made. Other performance items could be investigated in the same manner, such as speed increase or altitude increase.

Another parameter study is shown on slide 17. Actually, this comparison is a by-product of this synthesis process. The sample interceptor that we used did not include any requirements for a speed altitude plot except for the combat conditions at Mach 2, 60,000 ft. Slide 17 shows a comparison of three different engines that could be used to meet the combat condition of our interceptor, a turbojet, a turbofan and a ramjet.

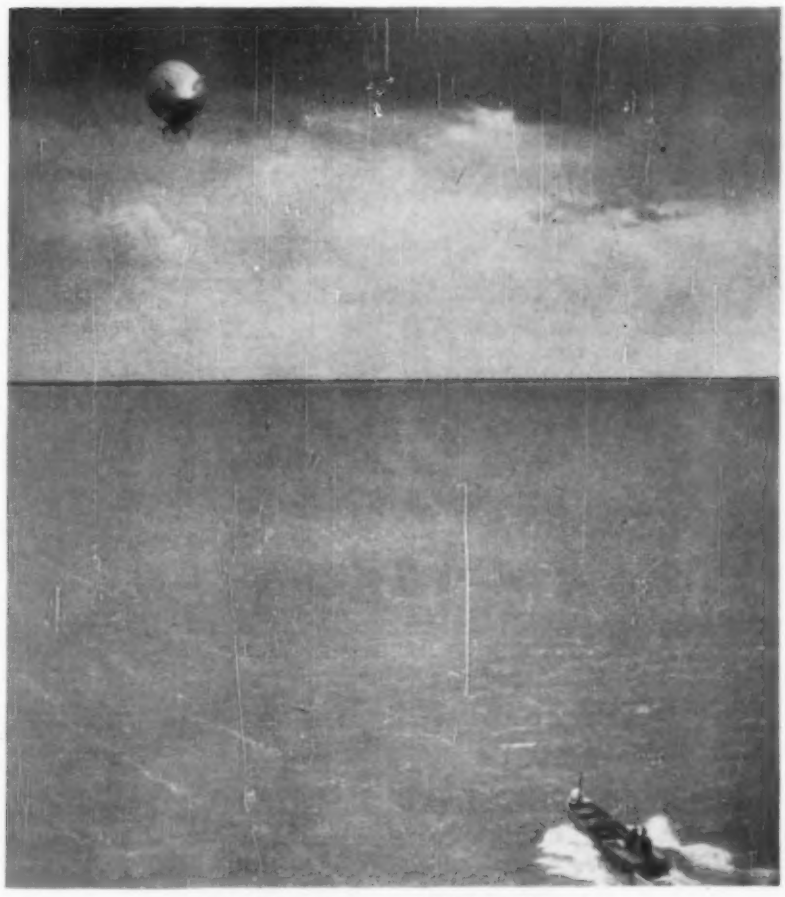
Low Speed Performance

However, the performance of this airplane at lower speeds is of interest and as is seen here, the turbofan and ramjet performances are inferior to that of the turbojet below the combat speed. The entire flight regime of the airplane is represented by the area enclosed by these curves. The ramjet performance goes to zero at some low speed and it is obvious that this airplane needs an additional engine in order to reach the high speed condition.

Besides the parameter studies that I have just mentioned there are many others that could be evaluated; tail size, wing planform, fuselage shape, etc. The takeoff weight is not the only criteria for optimization. It may be more important to reach combat in the minimum time. The design then would be optimized on a minimum time to combat. Operating costs may also be an optimization criteria.

Some parameters do not affect all of the engineering phases directly. Landing gear, for example, may not affect aerodynamics, however, all of these changes necessitate a new balance in order to completely evaluate their effects.

The machine process as described here is not limited as the sample may suggest. Different parameters may be fixed such as the engine. For an airplane design, there is usually a number of fixed engines that are available and



Airship Tows 40-ft. Boat

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these must be used in the design. The engine, in this case, cannot be "rubberized."

Other parts of the airplane may also be fixed, such as the wing area. This fixing can be carried into the extreme so that the entire airplane will not grow or shrink and the machine process becomes only a performance calculation. With this versatility, the process can be used in different phases of the airplane design. In the preliminary design phase it can be used as a tool for parameter studies. By fixing the engine to a certain size specified engines can be evaluated and by freezing the overall airplane size, performance can be investigated.

I have tried to cover a very broad subject in a very short period of time. Because of this I have eliminated most of the details of the process. However, I have covered the form used. Synthesization is a computing machine process used in the preliminary design of an airplane. All of the engineering phases normally used in preliminary design are represented in the machine in equation form.

Limitation of these processes are the machine set-up time that is required and the accuracy of the equation approximations to the different engineering phases. It has been found to be a very useful tool in the preliminary design phase in order to make the many parameter studies that are necessary in order to arrive at the optimum airplane design.

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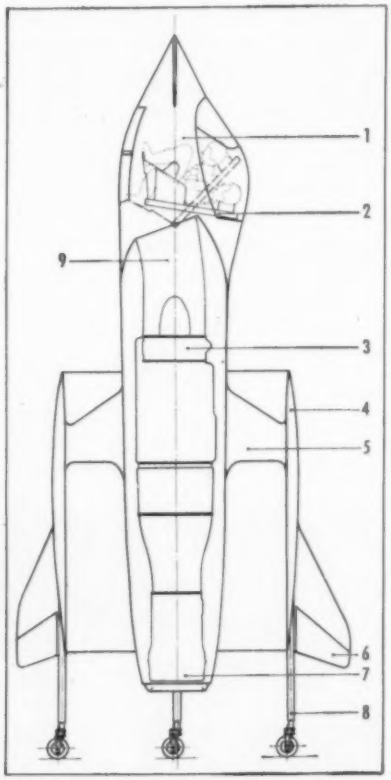


VTOL details: 1—cockpit, 2—swivel seat, 3—turbojet, 4—annular wing, 5—annular wing struts, 6—control surfaces for normal flight, 7—directional nozzle, 8—undercarriage, 9—air intakes.

Snecma Designs VTOL For Flying Atar Tests

Paris—Snecma will design a prototype VTOL aircraft to confirm in flight the windtunnel data it has compiled on the annular wing concept. Flights will be speed-limited and no attempt will be made to use the ultimate powerplant arrangement in which the annular wing becomes the outer shell of a ramjet.

Airflow effects during simulated vertical descents of the Snecma "Flying Atar" have been approximated during a series of tests on a moving railway train (AW Nov. 11, p. 37). Vehicle in these tests was the C 400 P.3, developed as the third stage in the "Flying Atar" program (AW Aug. 5, p. 50). The C 400 P.3 was mounted on a flat car and hauled at high speed over a stretch of track by a pair of locomotives from SNCF, the French national railway.

The "Flying Atar" was positioned

horizontally with the tailpipe pointing forward so that airflow around the engine would simulate conditions during a fairly rapid vertical descent. Train speeds between 25 and 50 mph. were used during the test.

Snecma says tests of the C 400 P.3 which, among other things, are expected to give much useful data on the unusual gimbaled pilot seat, will be followed by tests on the prototype shown in sectioned form here. Transition to and from the vertical flight regime will also be done in this fourth vehicle's flight tests.

PRODUCTION BRIEFING

Booz-Allen & Hamilton, management consultants, New York, told AVIATION WEEK that since 1950 they completed over 160 confidential assignments for seven aircraft manufacturers. In addition they said they did other consulting work for a number of aircraft parts manufacturers. They completed 40 assignments for four airlines during that time as well as other assignments pertaining to aviation for the government and other agencies. At present Booz-Allen & Hamilton's subsidiary, Applied Research, Inc., Chicago, Ill., has been doing research on intermittent combustion gas turbines and other projects.

Cartridge cases made out of Cycolac plastic (right) are lighter in weight and adequate in performance in comparison with usual brass cases, according to the Marbon Chemical Division, Borg-Warner Corp., Gary, Ind., which makes the high-impact resin. Tests made at the U. S. Naval Ordnance Laboratory,

White Oak, Silver Springs, Md., were said to show that the Cycolac cases, which weigh 2.5 lb. compared to 5.9 lb. for the brass, were able to withstand gas pressures ranging from 6,000-35,000 psi. and momentary flame temperatures exceeding 4,000F at the instant of percussion and in some instances have been re-used up to six firings.

a pressure pickup

smaller than a dime

withstands 200 G's

CEC's new miniature Type 4-320 Pressure Pickup operates at line pressures up to 300 psi . . . measures differential pressures in ranges from ± 7.5 psid to ± 50 psid, and gage pressures in the 25 psig and 50 psig ranges.
Ideal for airborne applications, the 4-320 features extremely small size (diaphragm diameter .475" x ¼" nominal thickness), light weight (4 grams), and ability to operate over a compensated temperature range of −65 to +250°F

Also available is the new Type 4-321 Pressure Pickup, which extends the applications of the 4-320 by providing it with a stainless-steel casing, one inch square and ⅜" thick. Although designed particularly for differential measurements, the 4-321 can be used for gage pressures by venting the reference inlet to atmospheric pressure. Write for Bulletin CEC 1579-X3.

Transducer Division CEC

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, Calif.

RECOGNIZED LEADERS IN GALVANOMETERS, TELEMETRY, PRESSURE AND VIBRATION INSTRUMENTATION

AT AVIONIC conventions, engineers spend twice as much time visiting exhibits as in listening to papers, recent survey shows.

Quality of Papers Sinks, Engineers Say

By Philip J. Klass

New York—Quality of technical papers read at avionic conventions is declining, judging from remarks written by engineers who responded to an AVIATION WEEK survey.

Many ideas for improving the usefulness of technical conventions as a medium for interchanging scientific information were revealed by the survey.

Survey questionnaires were sent to nearly 500 engineers picked at random from those who attended the last Western Electronic Convention. More than 200 of the engineers filled in and returned the forms.

Letter which accompanied questionnaire emphasized that survey was not intended to evaluate Wescon relative to other national avionic conventions.

Papers Rated

Voluntary comments written by more than half the respondents indicate that the quality of technical papers has dropped, probably as a result of the mushrooming number of avionic conventions which now total more than 30 per year. Half the papers were rated "poor" or "fair," the remaining half being rated "good" or "excellent."

AVIATION WEEK's survey reveals that engineers apparently spend nearly twice as much time visiting exhibitor's booths as they do listening to technical papers.

Here are a few of the ideas which appeared time and again in the space provided on the survey form for write-in suggestions:

• **Preprints should be** made available prior to the talk to enable engineers to familiarize themselves with the subject matter and to permit them to prepare well thought-out questions. This would enable the speaker to devote his limited time to the most significant points without having to go into background information or long mathematical derivations. Most conventions sponsored by the Institute of Radio Engineers, unlike those conducted by the Institute of the Aeronautical Sciences and the Society of Automotive Engineers, do not provide preprints. Notable exception is the annual Dayton Conference on Aeronautical Electronics where a bound volume of papers is handed out at time of registration.

• **Greater selectivity** in choice of papers is badly needed, the survey indicates. Many respondents urged that fewer papers be scheduled, limiting selection to those that offer "really new and creative ideas." Other representative comments include:

"Eliminate papers which present information that has already been published in trade and technical journals."

Another engineer says: "Make sure that papers deal with technical developments rather than merely a rehash of old ideas." Still another says: "Papers that describe recently developed hardware usually are dull and uninteresting except to others working on same specific type of hardware."

Widespread Criticism

Here are some of the most frequently voiced criticisms that appeared as write-in comments on the AVIATION WEEK survey forms:

• **Too much math** and complex circuit diagrams are included in oral presentation; should be left for the published version of the paper. One scientist wrote: "Very little information of a highly technical or theoretical nature is transferable to a convention audience. Individuals working in the same field can sometimes learn enough to ask questions of value to them. Preferably the talk should report on original work in such a way as to show significant results and stage of the development rather than the tedious details of its theoretical foundations."

• **Too many "sales pitches"** for company products are passed off as technical papers. "It is a crying shame to waste the time of so many engineers in listening to a speaker plug the products his company makes," is the comment of one engineer.

• **Too many simultaneous sessions** which result in missing certain papers of interest. One engineer says that most

technical conventions are "too much like a six ring circus." In this connection, several of those surveyed suggested that signs be posted in central locations and outside conference rooms to show what papers are currently being given and which ones are next on the schedule, to permit "session-hopping."

Novel Suggestion

One of the most novel suggestions submitted urged that small conference rooms be set up and that speakers be available in these rooms at a specified time following their talk to answer detailed questions from those interested in pursuing the subject in greater detail than is possible in the general question-and-answer session immediately following each talk.

Engineers surveyed were asked to indicate the general nature of their work in order to determine whether this influenced convention habits, likes and dislikes. Categories listed included research, development, design, system engineering, test and evaluation, sales, management and miscellaneous.

Of the more than 200 engineers who replied, 30% said their time was spent listening to technical papers, 55% in visiting exhibitors and the remaining 15% in technical bull sessions or on inspection tours sponsored by the Western Electronic Convention.

Analysis by Job

An analysis according to the type of work reveals that research and design engineers spent about 42% of their time listening to papers, almost 50% more than the average of the entire group, and 46% in visiting various exhibitors.

Sales engineers, on the other hand, spent only 8% of their time in technical paper sessions and 73% in visiting booths.

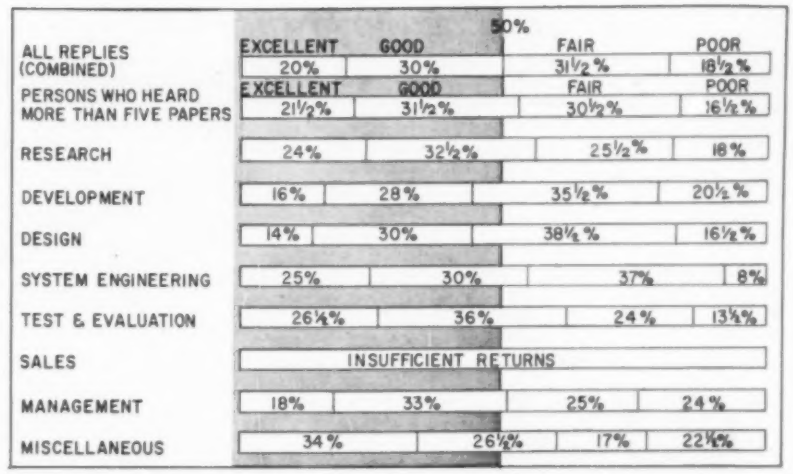
Approximately one out of six respondents (16½%) spent four days at the Western Electronic Convention, one out of five (21½%) spent three days, 19% spent two days and 43% spent only one day.

If an engineer had spent every possible moment during the four-day convention listening to technical papers, he might have heard approximately 40 papers.

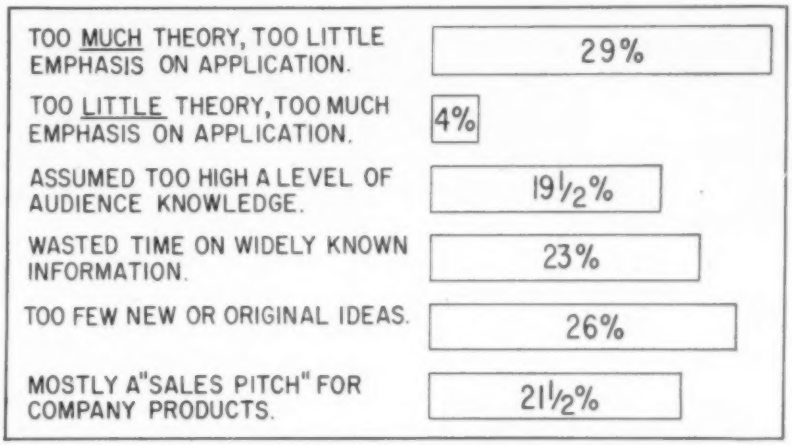
A breakdown of the total group shows how many papers were actually heard:

- **3½% of the group** heard 20 or more papers.
- **7½% heard** 16 to 20 papers.
- **6½% listened** to 11 to 15 papers.
- **21½% heard** 6 to 10 papers.
- **61½% heard** five papers or less.

AVIATION WEEK's survey asked respondents to indicate what percentage of the total technical papers they heard should be rated in each of the following four categories: excellent, good, fair



RATING of technical papers by more than 200 engineers who attended Wescon, based on usefulness and value, showing collective appraisal and analysis by type of engineering work.

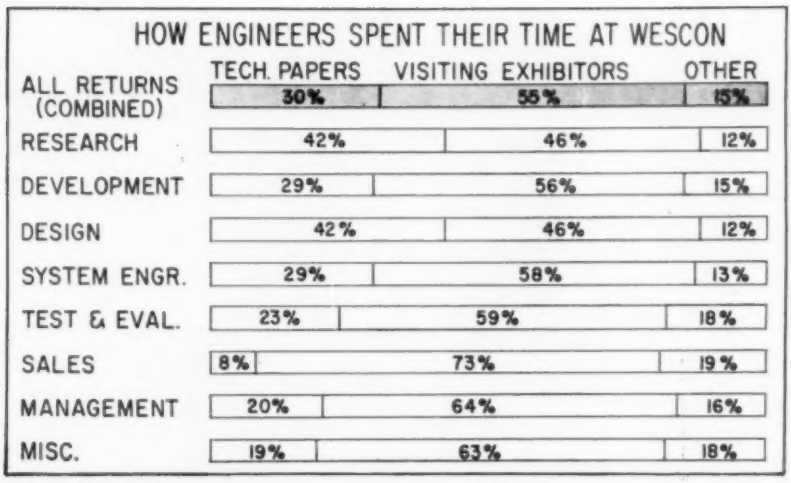

TOO MUCH THEORY, TOO LITTLE EMPHASIS ON APPLICATION. 29%
TOO LITTLE THEORY, TOO MUCH EMPHASIS ON APPLICATION. 4%
ASSUMED TOO HIGH A LEVEL OF AUDIENCE KNOWLEDGE. 19½%
WASTED TIME ON WIDELY KNOWN INFORMATION. 23%
TOO FEW NEW OR ORIGINAL IDEAS. 26%
MOSTLY A "SALES PITCH" FOR COMPANY PRODUCTS. 21½%

WHAT'S wrong with technical papers that fail to impress engineers is shown above in percentage of more than 200 engineers surveyed who checked one or more of these faults.

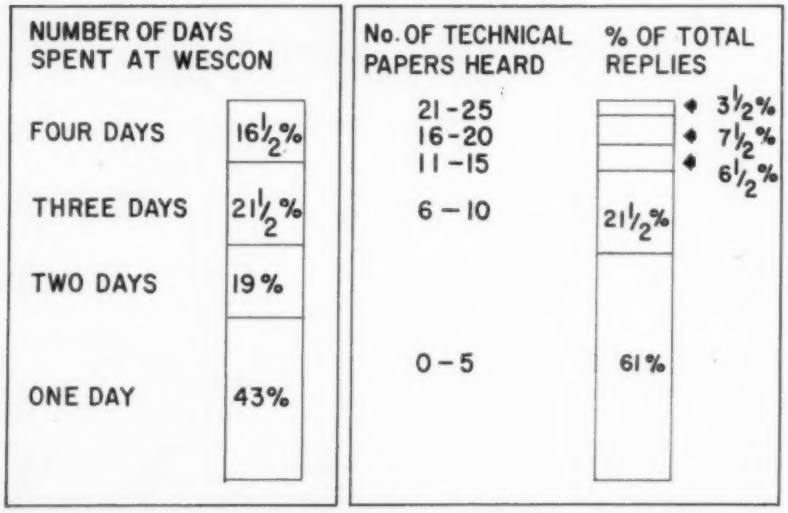
Engineers Speak

Here are some of the write-in comments on technical papers and conferences made by engineers in Aviation Week's survey:

- "Majority of papers have nothing unique to say and take too much time in arriving at an obvious conclusion."
- "Very little information of a highly technical or theoretical nature is transferable to a convention audience."
- "Too many speakers attempt to present all the detailed theory and design details which they spent six months or more in understanding or developing to a cold audience in 20 minutes. It can't be done."
- "Tell us what it is, what it does and how good it is. Leave the math and gory details for the convention record."
- "Get rid of 'sales pitches.' This is not in good taste at technical sessions and should be restricted to exhibitor's booths."
- "Reduce number of papers and improve quality. Discourage 'warmed-over' papers."
- "Papers should emphasize latest developments with details, math, proof, etc., left for published convention record for those who wish to wade through it."
- "Insist on dry run to prepare speakers in matters of delivery, timing and visual aids."
- "Most papers are of the 'so this is what I have done' type which have some educational value but do not stimulate the listener toward the solving of scientific problems."
- "Hate speakers who have to read a prepared paper. I can read it myself. Speaker who knows his subject doesn't have to read it."



AVIATION WEEK survey reveals how engineers spend their time at avionic conventions. Analysis of returns according to type of work shows researchers and designers spend more time at technical sessions than do engineers engaged in sales and management.



ANALYSIS of more than 200 engineers surveyed shows percentage of total that spent one, two, three or four days at Wescon, also number of technical papers heard during stay.

and poor. Analysis of all survey returns shows the following:

- **Excellent–20%.**
- **Good–30%.**
- **Fair–31½%.**
- **Poor–18½%.**

Because 61½% of the engineers surveyed heard five or less papers, AVIATION WEEK decided to make a separate analysis of returns only from those who had heard six or more papers. The results show surprising agreement with the appraisal made by the total group, as shown below.

- **Excellent–21½%.**
- **Good–31½%.**
- **Fair–30½%.**
- **Poor–16½%.**

Analysis of returns according to the nature of the respondents' work showed no great deviation from the overall average. Development and design engineers as a group were a little more critical than the average, giving only 44% of the papers a rating of good or excellent, compared to 50% for the entire group.

Engineers engaged in test and evaluation and system engineering found the papers more useful, the former giving 62½% a rating of good or excellent, while the latter gave 55% one of the favorable ratings.

What's Wrong

Prior to asking for write-in comments, the survey asked respondents to indicate principal shortcomings of those technical papers which they thought were of little value.

Survey listed six possible shortcomings, with spaces for others to be written in, and engineers were asked to check one or more.

Of the total replies, more than one quarter (29%) indicted papers for containing too much theory and giving too little emphasis on application. Only 4% leveled the reverse criticism of too little theory and too much application emphasis.

Twenty-six per cent criticized the papers for containing too few new or original ideas, and 21% accused the speaker of wasting time on information that was already widely known. Another 21½% criticized papers for being too much of a "sales pitch" for the speaker's company products, while 19½% indicted the speaker for assuming too high a level of audience knowledge.

Format Question

Engineers surveyed were asked whether they believed the usefulness of technical conferences would be improved by a change in format. Three possible changes were listed and respondents were instructed to check none, one or more.

- **Thirty-seven per cent** of respondents believed improvement would result by reducing number of papers delivered through greater selectivity and giving authors 40-50 min. for presentation.
- **Seventeen per cent** were in favor of limiting formal presentation to 10-15 min. in order to provide additional time for discussion from the floor.
- **Twenty-seven per cent** liked the idea of eliminating formal papers for certain subjects, like reliability, instrumentation, cooling, etc., and conducting an informal audience participation discussion seminar under the guidance of a qualified moderator.
- **Thirty per cent** appeared satisfied with the existing format and did not check any of the above changes.

Informal Seminars

The survey indicates widespread criticism of technical papers for failure to meet the needs of the listeners by giving too much or too little detail or presenting information of little value. One advantage of a seminar-type session is that the audience, by its questions and comments, can control the subject matter covered and direct the session along the lines of most widespread interest.

Barry Controls Inc. recently held an informal one-day workshop seminar on the subject of shock and vibration. The more than 40 industry-military representatives who attended were divided into three groups, each with a discussion leader and an assigned area for discussion.

AVIATION WEEK attended this Barry symposium and its on-the-spot observation suggests that the seminar format is extremely effective in stimulating the interchange of useful technical information. A subsequent Barry survey

questionnaire sent out to those who attended confirmed this observation.

Seminar workshop format may not be suitable for subjects where military security requires prior clearance for public comments. However, there are many other areas, such as management techniques, reliability, cooling, instrumentation and production techniques, where security is not a problem and where the seminar format might be attempted to good advantage.

AF Technical Libraries Lack Funds For Book Purchases, Translations

By James A. Fusca

Air Force research scientists, and technical personnel who monitor contracts, are seriously handicapped in gaining information about their respective fields because technical libraries at Air Force research centers are unable to purchase new books or supply badly needed translations because of insufficient funds.

Not only have sharply limited budgets prevented the acquisition of new technical data but one of the Air Force's largest research libraries has about 45% of its total collection in storage because it has been refused funds for expanding its shelf space.

The resulting lack of communication has caused duplication of entire research projects. A recently issued National Science Foundation report (NSF 57-35) gives the example of several American industrial laboratories spending five years and at least $200,000 on studies of electronic circuits for automatic translation. They subsequently learned that the Russians had completed and published results of an almost identical project in Soviet journals before their project started.

The problem is not new. Shortly after World War II, General Electric, under an Air Force contract for the study of precipitation static, developed a technique for seeding clouds with dry ice and silver iodide crystals to produce rain. The firm found, two years after the start of its work, that dry ice seeding had been described in reports published in Holland during the period 1930-33, although hindsight showed the General Electric approach to be the better one.

Major Problems

The primary problems facing the Air Force's research libraries are:

• **Lack of funds.** Beginning with cutbacks in 1947, these libraries have had to work with sharply curtailed budgets. Funds requested for the fiscal year beginning July 1 are not usually available before September or October while new budgets must be submitted in May. Limited local funds received cover, in most cases, only the most urgently needed acquisitions and subscription renewals.

• **Delay.** Because technical library acquisitions not purchased with local funds are lumped with the purchases for Air Force recreational libraries for central procurement by Air Materiel Command, average delay in obtaining technical books is three to four months, although sometimes it has been as long as a year. In November, requisitions for technical documents submitted last July were returned by Air Materiel Command with instructions that they be reduced by 80% for budgetary reasons.

• **Red tape.** Typical channels for central procurement by Air Materiel Command are: approval of requisition by Chief Librarian, approval by Chief of Technical Information and Intelligence Office, approval by Command Librarian of Air Research and Development Command, submission to central procurement contractor, contractor obtains approval of funds against the requisition from paying activity (Wilkins AF Depot, Shelby, Ohio), and finally contractor orders items on requisition from publisher or dealer.

• **Translations.** These libraries have no funds for staff translators and are not authorized to contract for translations. One result is that Air Force research laboratories were caught by surprise by the Soviet's use of 20 and 40 mc. for telemetry in Sputniks I and II despite two articles naming these frequencies that appeared in the Russian magazine Radio last June.

• **"Buy American" policy.** Present requirement that all procurement of technical documents be through publishers and dealers in this country prevents contacts with foreign suppliers who not only are the sole source for some material from Iron Curtain countries but that could have even greater importance as sources in the event of war.

Contract Monitors

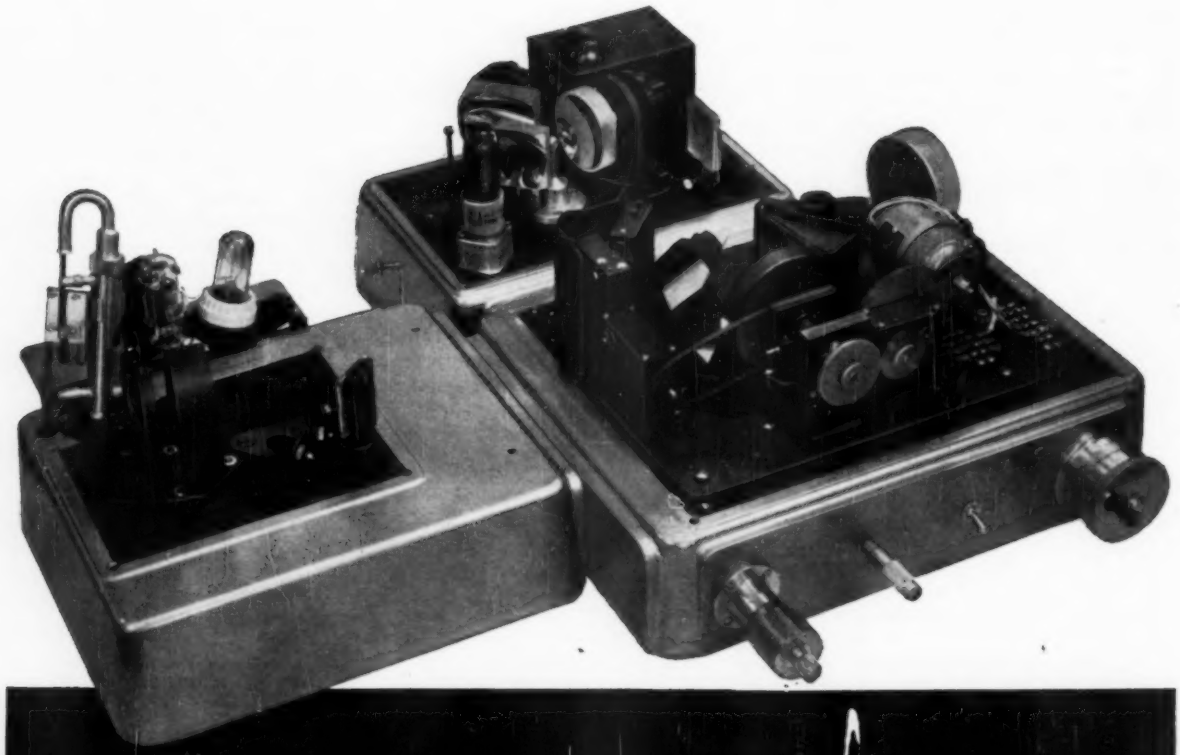
In administering research contracts placed with universities and industrial research laboratories, contract monitors are responsible for having a thorough knowledge both of past and present work in the field. This is not simply to avoid duplication of effort but also for the purpose of evaluating the results obtained.

For example, a large electronics laboratory recently completed a two-year study for the Air Force of radiation fields from slots in large circular cylinders. When the contract monitor pointed out that one conclusion of the study was at variance with results obtained by Lord Rayleigh and published in the January, 1904, issue of Philosophical Transactions, Lord Rayleigh was found to be right and the report was corrected.

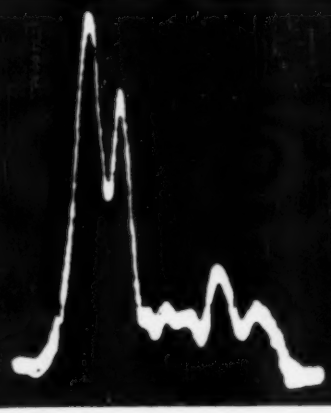
A large eastern university spent more

Radar Display Tube

Radar display storage tube, 70 times brighter than that of the average home TV screen, has been developed for full daylight viewing of airborne radar displays by pilots. Tube has been developed by Electron Tube Division of RCA.



Shown at right are traces (2-3) of a polystyrene sample made at a speed of 15 spectra per second over a scan interval of 6.8-13 microns. Specifications for a rapid scan instrument vary according to the use to which the instrument is to be put. A typical instrument has a wave length range of 0.20 to 13.5 microns with fused silica or NaCl prism; effective aperture of f/5.0; scanning frequency adjustable from 2.5 to 90 cycles per second; and scan interval continuously adjustable from essentially zero to the complete wave length range.



this rapid-scan spectrometer

RECORDS 15 SPECTRA / SECOND IN THE FAR INFRARED

For combustion analyses, for gas emission studies, for analyses of continuing reactions – the Perkin-Elmer Rapid Scan Spectrometer offers performance unobtainable with conventional instruments. Here's how Perkin-Elmer's "building block" concept makes possible the unusual versatility of the Rapid Scan Spectrometer:

The Rapid Scan Spectrometer is a Perkin-Elmer "building block" instrument – that is, an instrument composed of the advanced spectrometric components – or building blocks – which Perkin-Elmer has developed for use in custom built instruments for specialized analytical jobs.

The P-E Rapid Scan Spectrometer consists of four components: a radiation source assembly, a rapid scan monochrometer, a radiation detection system and a read-out unit. By selecting the right building blocks to fill each function, Perkin-Elmer can supply an instrument to analyze any part of the electro-magnetic spectrum from ultraviolet through infrared, with scan speeds from 5 to 180 spectra per second.

The "building block" concept is a result of Perkin-Elmer's long leadership in the field of spectroscopic instrumentation. It enables Perkin-Elmer to build an instrument to solve almost any specialized problem in spectrometric analysis. For information on individual components or complete instruments, write us at 900 Main Avenue, Norwalk, Conn.

INSTRUMENT DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT

than one and one-half years studying the forward scattering of plane electromagnetic waves from a sphere. When the final report was submitted, the contract monitor pointed out that the results disagreed with those obtained in an identical study by F. P. White, published in 1922 in the Proceedings of the Royal Academy. This conflict has not been resolved to date.

In these instances the contract monitor was able to assist the government in obtaining the maximum return for its research investment. The critical lack of funds for government research libraries may, however, at this time be costing much more than it is saving in blind-alley or redundant research projects.

A typical example of disproportionate budgeting is the Air Force Cambridge Research Center. The Center is responsible for spending more than $30 million this fiscal year for research but its budget for library facilities, including the handling of military documents and contract reports, has been cut to $32,000. This is less than the cost of one inexpensive but misguided research project.

Expansions, Changes In Avionics Industry

Federal Telecommunication Laboratories formally has opened its new 22,400 sq. ft. San Fernando, Calif., laboratory which will be used for research and

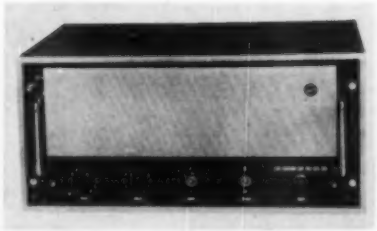
development in the fields of infrared, inertial navigation, low-temperature physics and solid-state physics.

Other recently announced expansions and changes in the avionics field include:

• **Marconi Instruments** has moved from New York City to larger quarters in Englewood, N. J. Address: 111 Cedar Lane.

• **Mycalex Corp. of America's** Pacific Division offices are now located at 2810½ Glendale Blvd., Los Angeles 39, Calif.

• **Drexelbrook Consulting Service,** 1417 Edgehill Rd., Abington, Pa., is name of new company which will assist manufacturers of instrumentation and control devices, conduct new product studies and assist insurance companies in studies on use of instruments in explosive hazard areas. Company is headed by F. L. Maltby, formerly technical director of Robertshaw-Fulton Controls Co. Instrument Division.



Aeronautical Receiver

Ground station receiver, Type 117R244, for reception of aeronautical communications in the 1.6 to 8.0 mc. band, is available in both single and double-channel models. Receiver delivers one watt audio from input signal of less than one microvolt. Signal reportedly is more than 6 db. down at 3 kc. from center frequency, 60 db. down at 11.5 kc. For greater selectivity, mechanical filter is available. Price of standard single channel model is $196; dual-channel is $226. Kaar Engineering Corp., 2995 Middlefield Road, Palo Alto, Calif.

• **Stephen F. Malaker Associates,** Newark, N. J., is new consulting firm which will specialize in field of nuclear energy. Address: Federal Trust Bldg.

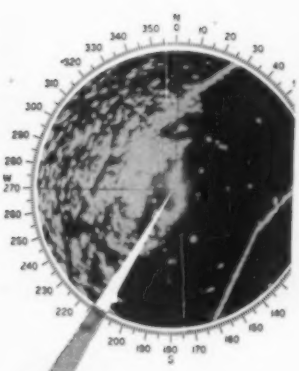
• **Consolidated Controls Corp.** will begin occupancy of new plant facilities in Bethel, Conn., in January and complete the move from present Danbury, Conn., location by following month.

• **United ElectroDynamics** has opened new integrated avionic testing laboratory called **United Testing Laboratories** at 573 Monterey Pass Road, Monterey Park, Calif. New facility occupies 30,000 sq. ft., employs staff of 60 engineers and technicians and is set up to conduct tests on electronic, mechanical, pneumatic or hydraulic devices.

• **Behlman Engineering Co.,** Burbank, Calif., maker of power supplies and custom instrumentation, has moved to new larger quarters at 2911 Winona Ave.

• **Capitron Division** is new name of the former **AMP Inc.** Chemical & Dielectric Division. The division, which produces capacitors, networks, transformers and power supplies, is located at 155 Park St., Elizabethtown, Pa.

• **Consolidated Electrodynamics Corp.,** Pasadena, Calif., has licensed **Solartron Electronic Group Ltd.,** Surrey, England, to produce and sell CEC's magnetic tape recording and reproduction equipment for avionic instrumentation use.



Hostile ICBM!

Already Airborne . . .
Heading this Way . . .
Seconds to go!

There may be time enough to get one flight of interceptor missiles off — if installations are alert. **But what chance that even one missile killer will make contact?** Excellent, with infrared guidance.

That's because infrared homes tenaciously on the target and **won't** shake off. Where there's heat there's infrared, and the detection head "locks on". The faster the invader's speed, the greater the heat, the stronger the infrared signal... just about impossible to jam or mask.

Servo Corporation of America, pioneer in infrared weapons systems, is ready with infrared systems for America's defense . . . has them ready and waiting. That newest missile of the Air Force, able to snipe the wingflares off a coasting drone, is trained and tuned with Servo infrared equipment. Or back when the Navy made the **first** strike at Point Mugu to prove the effectiveness of ground-to-air missile action, it was a Servo infrared seeker head hitting the bull's eye then, too.

Servo Corporation, with its preeminence in infrared and electronics weapons systems, continues ready to strengthen the nation's defense—both in prime contract production for the armed services and through subcontracting for other manufacturers.

FREE: *The booklet, Infrared Weapons Systems, gives a roundup of declassified data on infrared military equipment. Rush your request for Special IR Report "Around the Servo Circuit", to:*

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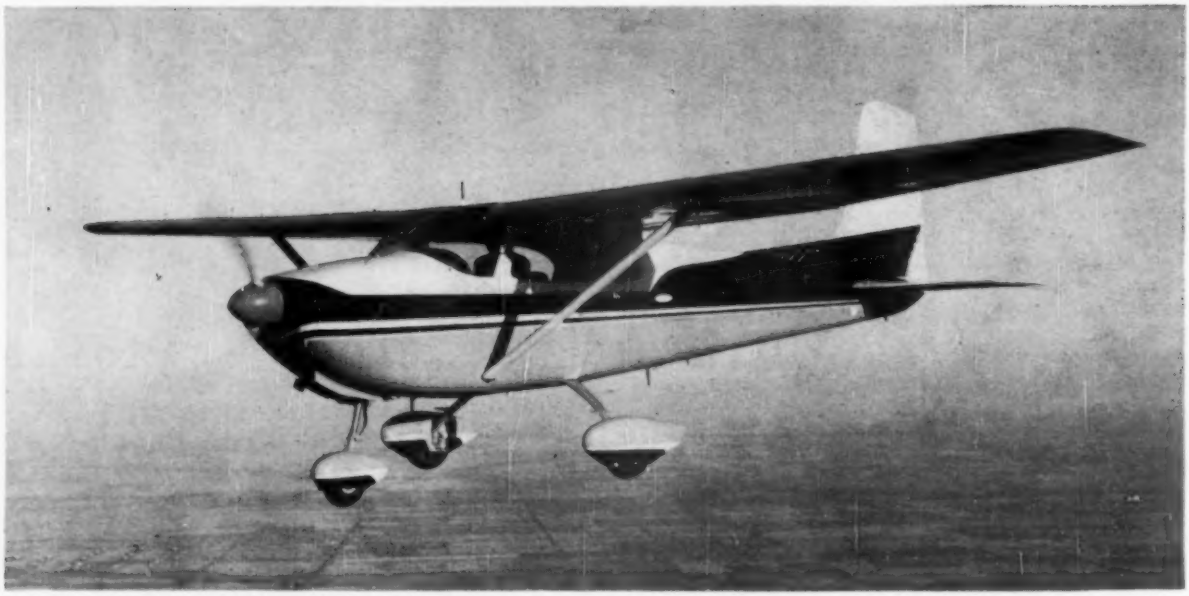


FIBERGLAS WHEEL FAIRINGS set de luxe style note on Skylane, offered to customers as a completely equipped ready-to-use package.

Cessna Introduces Skylane in Sales Drive

MODEL 180 features detail improvements of other models, including a new interior.

MODEL 182 has many of Skylane's features, including new directional trim control.

By Erwin J. Bulban

Sales goal of more than 50% of 1958 business aircraft market was set by Cessna Aircraft Co. to its distributors and dealers at recent unveiling at Wichita, Kans., of its line for the coming year.

Star of the 1958 will be a deluxe version of its 182 named the Skylane, which is planned to provide the purchaser with a fully equipped package of factory installed equipment. Flyaway factory price will be $16,850. Customers will have a choice of Lear or Narco omni-transceiver with crystals and low frequency range, directional and horizon gyros, sensitive altimeter, clock, outside air temperature gage and rate of climb and turn and bank indicators.

New Skylane, basically a dressed-up Model 182, can be recognized by its Fiberglas pants on all three wheels and a three-color exterior paint scheme that completely covers the airplane. Customers will have a choice of any three of eight different colors.

Wheel fairings serve mainly to add a deluxe style note to the airplane. Performance gain they provide is approximately three miles per hour. Factory ran a series of "mud tests" to determine a design that would minimize blockage problems.

Other changes in the 1958 "Mighty Middle Line," as Cessna tags its Skylane, 182 and 180 series, include addi-

tion of a directional trim control forward of the trim tab and flap control handle to provide easier handling on cross country flights.

A right-hand exhaust outlet has been incorporated in all these models, forcing gases down under the center of the fuselage to eliminate previous visible staining and discoloration, and improved windowsealing and instrument panel lighting. Instrument panel is black Royalite plastic to reduce glare. Additional detail changes include relocating the door handle lock to the aft end of the door handle to prevent inadvertent forcing of the handle when door is locked.

Fuel, oil and oil pressure gages have been grouped together and tachometer and manifold pressure gages are now standard size instruments.

Standard versions of the 182 will be priced at $14,350 and the 180 cost $13,850 F.A.F., Wichita.

New accessories being offered as gages are now standard size instruments. factory-installed equipment on all

CESSNA LINEUP, from bottom: Model 172, Model 182, Skylane and Model 310B.

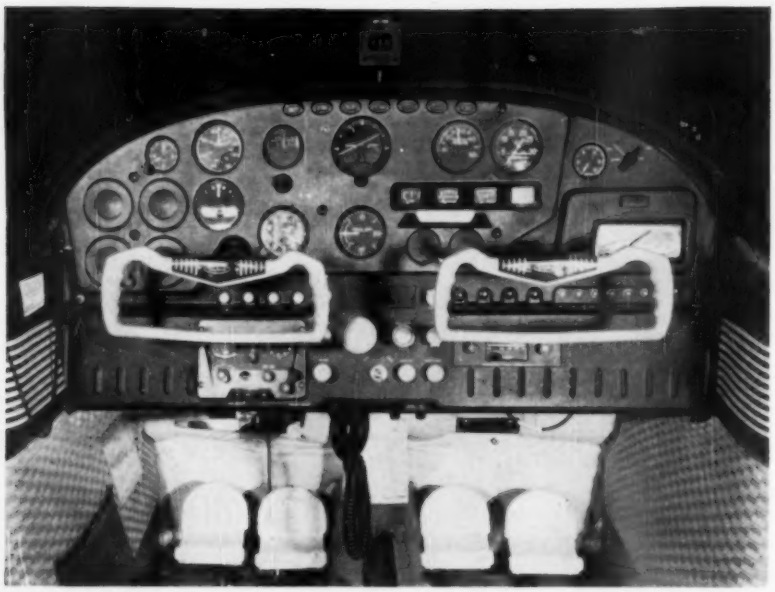
1958 Cessna 180-182 Line

	Skylane	182	180	180 Floatplane	180 Amphibian
PRICE:	$16,850	$14,350	$13,850	*	**
ENGINE: Continental (6-cylinder) 230 hp. @ 2,600 rpm	O470-L	O470-L	O470-K	O470-K	O470-K
SPEED: Maximum—sea level	168 mph.	165 mph.	170 mph.	149 mph.	149 mph.
Maximum recommended cruise 70% power @ 8,000 ft	158 mph.	155 mph.	160 mph.	146 mph.	146 mph.
RANGE: Range @ Max. Recommended Cruise					
Miles	667 mi.	655 mi.	675 mi.	615 mi.	615 mi.
Hours	4.2 hr.	4.2 hr.	4.2 hr.	4.2 hr.	4.2 hr.
True Air Speed	158 mph.	155 mph.	160 mph.	146 mph.	146 mph.
Maximum Range					
Miles (10,000 ft. no reserve)	819 mi.	805 mi.	845 mi.	820 mi.	820 mi.
Hours	7.1 hr.	7.1 hr.	7.1 hr.	7.4 hr.	7.4 hr.
True Air Speed	116 mph.	114 mph.	120 mph.	110 mph.	110 mph.
RATE OF CLIMB (sea level)	1,030 fpm.	1,030 fpm.	1,130 fpm.	1,070 fpm.	1,055 fpm.
SERVICE CEILING	19,800 ft.	19,800 ft.	21,500 ft.	17,000 ft.	16,800 ft.
GROSS WEIGHT	2,650 lb.	2,650 lb.	2,650 lb.	2,820 lb.	2,850 lb.
EMPTY WEIGHT	1,560 lb.	1,560 lb.	1,555 lb.	1,822 lb.	2,034 lb.
LUGGAGE COMPARTMENT ALLOWABLE LOAD	120 lb.	120 lb.	120 lb.	120 lb.	120 lb.
FUEL CAPACITY (Range based on 55 gal. usable fuel)	65 U.S. gal.	65 U.S. gal.	65 U.S. gal.	65 U.S. gal.	65 U.S. gal.
SPAN	36 ft.	36 ft.	36 ft.	36 ft.	36 ft.
LENGTH	26 ft.	26 ft.	26 ft.	26 ft.	26 ft.
HEIGHT	8 ft. 6 in.	8 ft. 6 in.	7 ft. 6 in.	12 ft.	12 ft. 4 in.
WING AREA	175 sq. ft.	175 sq. ft.	175 sq. ft.	175 sq. ft.	175 sq. ft.
WING LOADING	15.1 lb./sq. ft.	15.1 lb./sq. ft.	15.1 lb./sq. ft.,	16.1 lb./sq. ft.	16.3 lb./sq. ft.
POWER LOADING	11.5 lb./hp.	11.5 lb./hp.	11.5 lb./hp.	12.2 lb./hp.	12.4 lb./hp.

*Floats $4,585 additional, plus approximately $200 installation cost.

**Amphibious floats $9,950 additional, plus approximately $400 for initial installation.

All performance figures are at gross weight.



SKYLANE PANEL features Lear or Narco omni-transceiver as standard, plus other gear.

three models will include the Tactair T-3 pneumatically-operated autopilot, which weighs under 12 lb. installed and an 18-gal. auxiliary fuel tank, which can be installed in the baggage compartment. The plastic wheel fairings, standard for the Skylane, will be available on the 182.

Cessna already is delivering its 1958 Model 172, priced at $8,995, an increase of only $20 over the 1957 model. Major change on the new 172 is reforming of main landing gear spring steel struts, sweeping the wheels back three inches to improve ground handling and stability.

Not yet shown is another of its high-wing tricycle-gear models, the new Model 175, which is planned to fall between the 172 and 182 in price range. This airplane is expected to make its debut later this month or in early February.

New "middle line" Skylane, 182 and 180 models will be introduced at series of automobile-type display showings at the company's dealers throughout the country in January.

New Zealand Flying Largely Agricultural

Rapid growth of agricultural flying in New Zealand is pointed up by a recent government report which indicates that in the past year more than half of all the commercial flying hours in that country were accounted for by aerial farming services.

Currently there are some 70 agricultural aviation operators using more than 300 airplanes in New Zealand, compared to about five firms in 1949. In the year ended March, 1957, agricultural aircraft dropped 428,000 tons of fertilizer in New Zealand, accounting for nearly half the country's production of this item. In 1949, planes accounted for 5,000 tons. In the seven years that agricultural aviation has become established on a commercial basis in New Zealand, planes have dispensed nearly 1.6 million tons of fertilizer on nearly 15 million acres. Increased farm productivity as a result has, in turn, built demands for subsidiary use of aircraft in such tasks as seed sowing, rabbit poisoning, spraying and supply dropping, including delivery of fencing material.

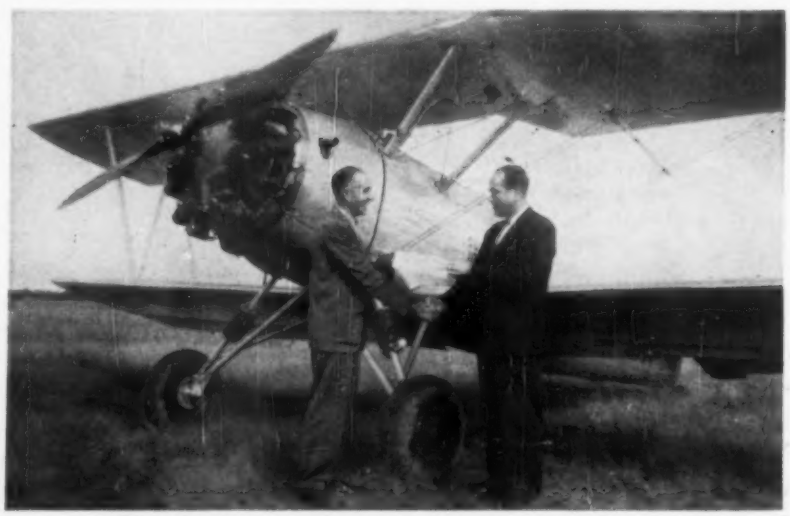
Government notes that the rabbit menace which previously cost the country millions of dollars in depleted pastures has been largely eradicated through use of aircraft.

Subsidy payments to clubs by the government have resulted in an increase in private flying in New Zealand; in the year 1956-1957, the government paid out some $73,000 to offset the cost of training 252 new pilots. Pupils get a refund of half the cost of his training fees, to a maximum of about $120. Club gets a quarter of the cost of training to a maximum of about $60.

In addition, the government pays the clubs a certain amount for each hour flown by its planes, with an additional fee for all flying time in excess of 200 hr. a year to encourage high utilization.

In 1949 there were 22 active clubs in New Zealand, with a fleet of 108 planes, mostly surplus equipment. Some 600 pupils were taking courses. Currently, there are 32 clubs training 6,180 members. Government policy has been to encourage clubs to eliminate older, war surplus aircraft and replace them with newer types; as a result there are currently 105 airplanes in the total fleet.

There are also now 12 gliding clubs affiliated with the New Zealand Gliding Assn., with 400-500 members and 26 gliders with airworthiness certificates. There are also four parachute clubs.



Clark Spray/Duster Gets Certificate

John C. Clark, left, president of Clark Aircraft, Inc., Marshall, Tex., receives CAA Type Certificate for Model 1000 agricultural plane from W. H. Messick, Region 2 Field Manufacturing Inspector. Airplane is approved for 220-hp. Continental and McCauley propeller, alternate powerplant installations are being approved. Normal cruise speed is 80-90 mph. A Fiberglas hopper-tank, with 160-gal. capacity, is mounted ahead of the pilot. Structure is all-metal stressed skin, except for outer wing panels, which have spruce spars for easy field repair and maintenance. Price is under $10,000.

Pattern check for the first stage drive gear for the Sikorsky S-58 Helicopter. The large gear is concave, cannot be ground and must be carburized and hardened with sufficient freedom from distortion to maintain pattern and tolerances expected only of master gears.

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Vought Vocabulary

cham′pi·on: *the fighter whose record is written on aviation's most honored trophies*

Again the aviation world salutes the F8U-1 *Crusader.* The Collier Trophy, one of America's highest tributes, has been awarded to the Navy and to Chance Vought for 1957's most significant aviation achievement: development of this record-smashing jet fighter.

The *Crusader's* first triumph was the 1,015 mph national speed record that won the coveted Thompson Trophy. Next came history's first cross-continent, ocean-to-ocean, carrier-to-carrier flight. Following that flight, a *Crusader* streaked across the nation in "Operation Bullet." This 203-minute flight set an official world's record and marked the first supersonic crossing of the U. S.

The blazing performance that has taken aviation's top honors brings unmatched air combat strength to the U. S. Navy. The Vought *Crusader* is now aboard Fleet carriers . . . strengthening America's power for peace.

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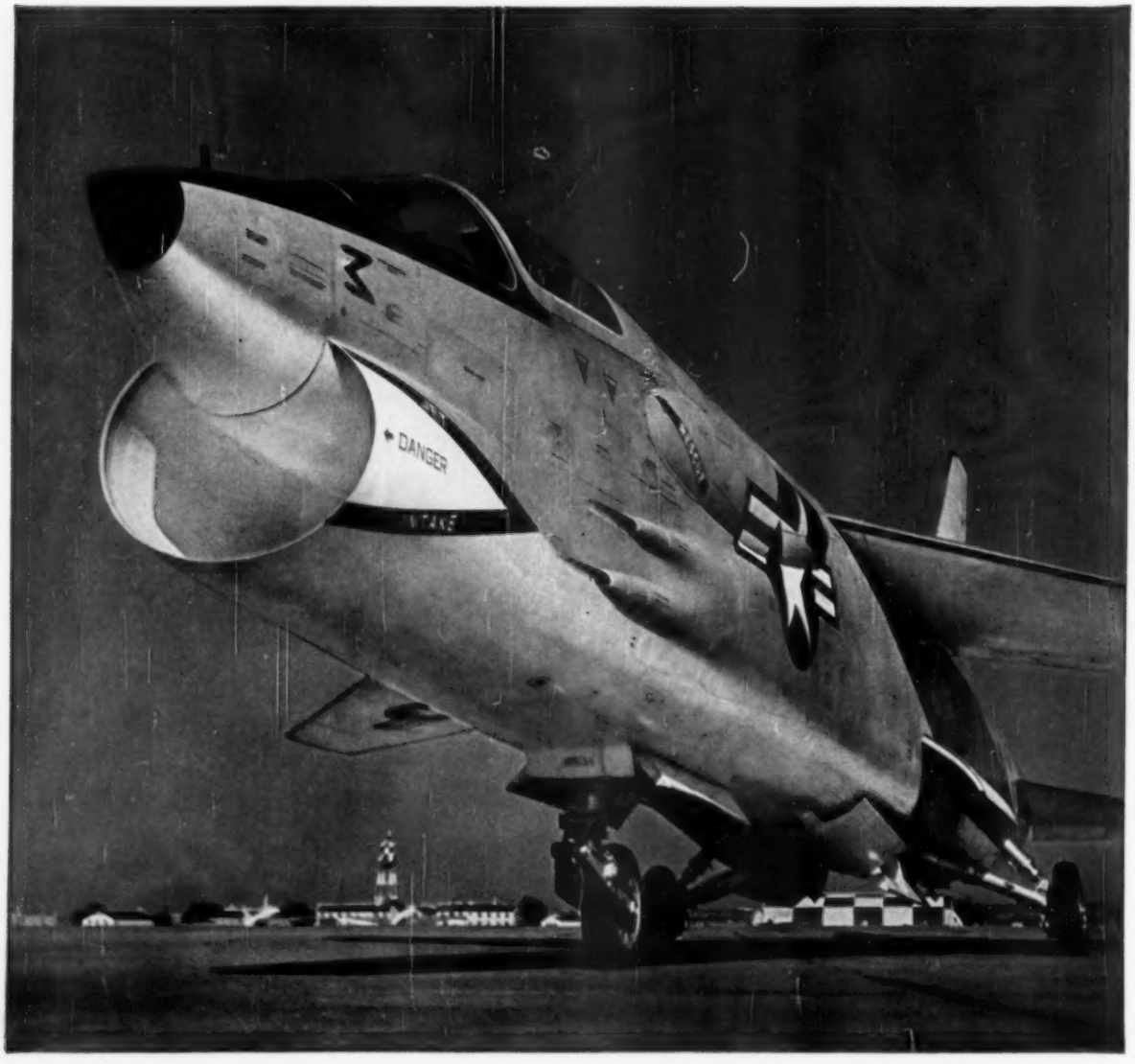


MARK 22 light twin aerodynamic prototype is scheduled to start flight tests in March. Company considers it an early 1960 airplane. Resemblance to single-engine Mark 20s in background is readily apparent. Prototype has 150-hp. engines, but production versions will probably use 180-hp. Lycoming O360s. Large dorsal fin was not on earlier sketches of Mark 22 (AW Dec. 30, p. 23).

Mooney Shows Latest Executive Planes

MARK 20A is advanced model of Mark 20 with 180-hp. Lycoming O360, which gives it a speed increase of 15 mph. to 180 mph. compared to previous model. Gross weight of 2,450 lb. is retained, range and other performance is similar to Mark 20. Company plans to produce both models in 1958.

Rudder Control Unit Gets CAA Approval

Civil Aeronautics Administration approved Lear Super Arcon automatic rudder control equipment without restrictions as to when it is engaged providing, in effect, permission to use the device from engine-on to engine-off operation.

Company sought such certification on the basis that its Super Arcon installation is a positive lateral stability device that should be installed so that pilot cannot inadvertently turn it off. Super Arcon has a spring-loaded button on the plane's control wheel which must be held down to deactivate the system and which, when released, automatically reactivates it. Forces can also be overridden by moving the wheel.

Lear points out that continuous engagement of the Super Arcon has particular value should a multi-engine aircraft suffer an engine failure on takeoff. During demonstration to CAA, Lear simulated an engine failure in a Piper Apache light twin immediately after takeoff by cutting one engine back to idle; the rudder control prevented abrupt yaw, and with the engine windmilling and rudder untrimmed, allowed only slight turning toward the "dead" engine. With the engine feathered, and rudder still untrimmed, yaw was entirely eliminated, Lear reports.

Super Arcon has an all-transistorized amplifier, which incorporates a short-term memory that will correct for yaw deviations. If, during the memory period, there are more deviations to one side than the other, an extra computed signal is sent to the servo to compensate for the accumulated displacement. Unit also has provisions for tie-in to a directional gyro to provide for long-term heading hold assist.

Bristol Begins Helicopter Ground Rig Tests

First turbine-powered helicopter ground rig built by Bristol Aircraft undergoes preliminary running tests at Bristol's helicopter center at Weston-super-Mare. Twin engine tandem rotor configuration, powered by two Napier Gazelle free turbine engines, is first of two that have been constructed to develop and test the engines, transmissions and rotor head systems that will be used in production models of the Bristol Type 192 helicopter. Each Napier Gazelle develops 1,650 shp.

PRIVATE LINES

Lightweight ground-based weather radar tracking system, utilizing most of the components of RDR-1 airborne radar, has been developed for airports, government agencies and local weather stations by Bendix Aviation Corp. Repackaging airborne system to new set provides conversion of 60-cycle power to 400-cycle, a new plastic radome that houses antenna, power and transmitting-receiving equipment. A 12-in. radar indicator console replaces the 5-in. airborne unit. System, weighing under 200 lb. complete, will be available in C-band and X-band.

License to produce Italian-designed Macchi M.B.308 three-place lightplane has been granted German Bianco, S.A., Buenos Aires, which expects to begin output in about six months, with Macchi supplying components for first 100.

Federal autopilot has been approved for Piper Apache and first installation has been made in light twin business plane owned by Sweet and Crawford, insurance firm.

Contract to inspect and overhaul all Bell H-13 helicopters in 13 eastern states has been granted Doman Helicopters, Danbury, Conn. Contract, covering aircraft of 1st and 2nd Armies, will run one year.

Cost of Tactair pneumatically operated autopilot in 1958 Beech J35 installed at the factory is $2,850, not $1,300 as reported inadvertently in AVIATION WEEK Dec. 9, 1957, p. 115.

Twin-jet executive transport prototype is being built by Avions Marcel Dassault. French firm's first commercial aircraft since World War II will be a nine-passenger sweptwing type with cruise speed of approximately 700 mph. and range of some 1,700 mi. Engines will be Dassault-built Armstrong Siddeley Viper jets of about 3,000 lb. thrust each, podded under the wings. First flight of Dassault Mediterranee is expected by end of 1958.

Travel Air Spans Three Decades

Private flying progress in the past three decades is pointed up by this unusual formation photo of a Travel Air 2000 three-place biplane of the late 1920s and new Beech four-place Travel Air, which is reaching the market this year. Biplane is one of a number of oldtime aircraft restored as a hobby by Lou Anderson, spray/dust operator of Mansfield, Mo. It is powered by a 1919 OX engine that he found in its original crate stored in Chicago. Plane was licensed by CAA in October. Anderson averaged 65 mph. on his flight to Wichita, Kans., to attend recent Beech distributors and dealers convention; new light twin Travel Air cruises at 200 mph.

Report Urges Unified USAF Management

By Robert I. Stanfield

Need for USAF to streamline and modernize its managerial control functions as they relate to development and procurement of weapon systems and manpower was stressed in the fifth report of the Advisory Board of the Air Training Command.

Study, over a year and a half in the making, pointed up the growing emphasis on missile development and the present lack of policies and programs which would guarantee an adequate "force in being" in event of war.

Report underscored the need to hold highly trained personnel who leave service just when their training is about to pay off. It also noted "the cavalier manner" with which recommendations of the Cordiner Committee (AW Aug. 26, p. 25) have been handled by Congress, Bureau of the Budget and civilian management of Defense Department.

Twenty-member civilian board, headed by Dr. Samuel N. Stevens, president, of a Chicago firm specializing as consultants in personnel administration, presented the report to the commander of Air Training Command at Scott AFB, Ill. Board attempted to answer these two questions:

Basic Aims

• **How may the Air Force** retain a large number of airmen and officers of high competence and integrity?

• **What are the factors** which preclude the achievement of a greater stability in the programming and funding of the basic mission of the Air Training Command?

Its recommendations, the Board feels, would increase efficiency of Air Force management and would accelerate adjustments necessary to the "coming of age of missiles." Recommendations include:

• **Program and budget.** Establishment at Headquarters, USAF, of a program integration group aimed at providing the means by which balanced programs, including compatible funding provisions for personnel, operations and construction, would be provided all Air Force commands.

• **Personnel structure.** Initiation at Headquarters, USAF, of high-level study to review present personnel administration field and propose reorganization providing for a Personnel Management Agency with jurisdiction over personnel functions presently allocated to five separate USAF agencies.

• **Pay.** Proficiency pay for servicemen in occupational categories that are in critical demand by USAF and industry alike. Board feels that though not entirely satisfactory, recommendations of Cordiner Committee are a step in the right direction.

• **Housing.** Establishment by USAF of clear-cut standards of minimum acceptable housing and living conditions before personnel would be assigned to a particular base.

Leadership and Procurement

Study also called for revision of Reserve Officers Training Program. It advised that all newly commissoned graduates be placed in an officers' training school for minimum of six months. Qualified applicants would continue on active duty; others would revert to reserve status for the period necessary to complete their military obligation.

Turning to officer procurement, report suggested that a limited number of universities be asked to provide courses leading to degrees in Military Science.

Graduates would be offered permanent commissions.

On the question of airman procurement and separation, report recommended initiation of more selective recruiting procedures, plus the possibility of putting selected airmen on "permanent" appointment. It was also suggested that airmen be required to seek separation at the end of their enlistments rather than be required to reenlist.

Stating that with the increased complexity of the weapon system, one untrained man can impair a vital mission, Board recommended that unit rotation be adopted throughout foreign assignments. This, it feels, would further "team concept" and morale, and remove uncertainty about new men in key assignments.

Report also noted lack of Air Force effort in personnel classification. It stated that the weapon systems concept mandates a greater association between the weapon system and the individual in all procedural actions.

Board called for the planning and installation by Headquarters, USAF, of a completely integrated high-speed electronic data automation system through which USAF could best utilize its available manpower.

Board feels that as more assistance is required from contractors in training and equipment weapon system maintenance, it also seems logical to consider the classification of such skills and their availability as supplemental "emergency personnel."

Today's System

Personnel system as it now stands requires collection, formulation and dissemination of personnel data from five separate Air Force agencies:

• **Air Research & Development Command**—personnel requirements on new weapons.

• **Directorate of Personnel Planning,** Headquarters, USAF — classification structuring.

• **Air Training Command** — training standards and plans.

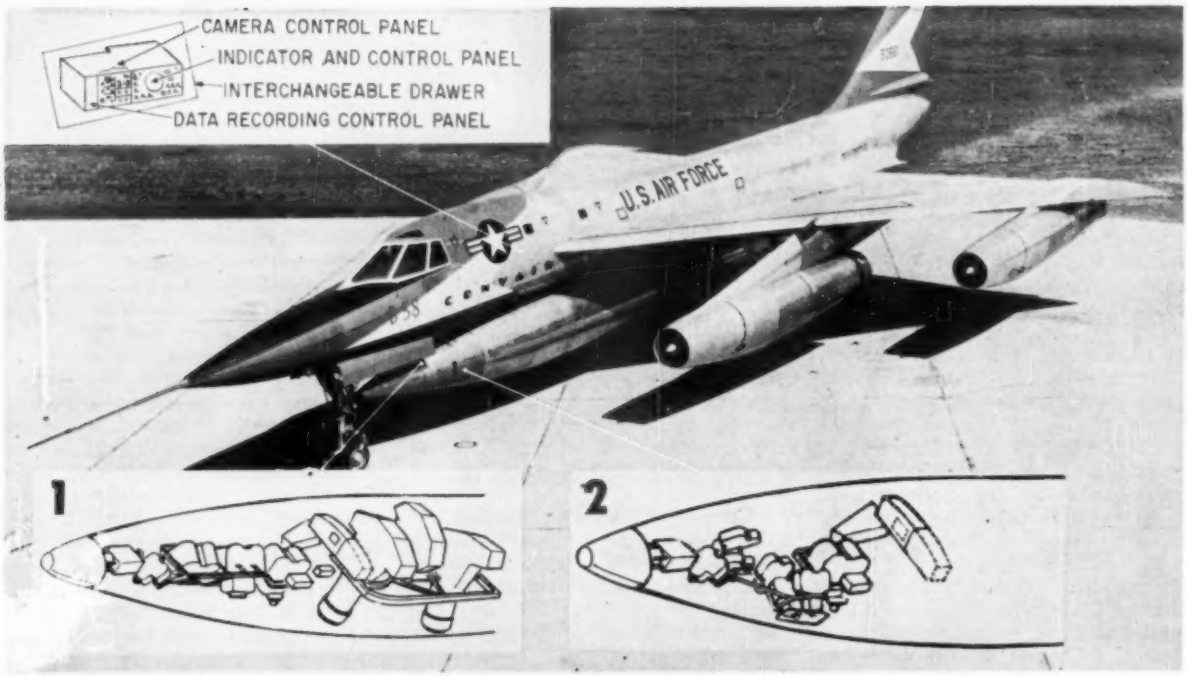
• **Continental Air Command** — proficiency tests.

• **Directorate of Manpower & Organization,** Headquarters, USAF—manpower guides.

Before submitting its recommendations, Advisory Board visited USAF locations in the U.S., Europe, North Africa, Alaska and the Far East.

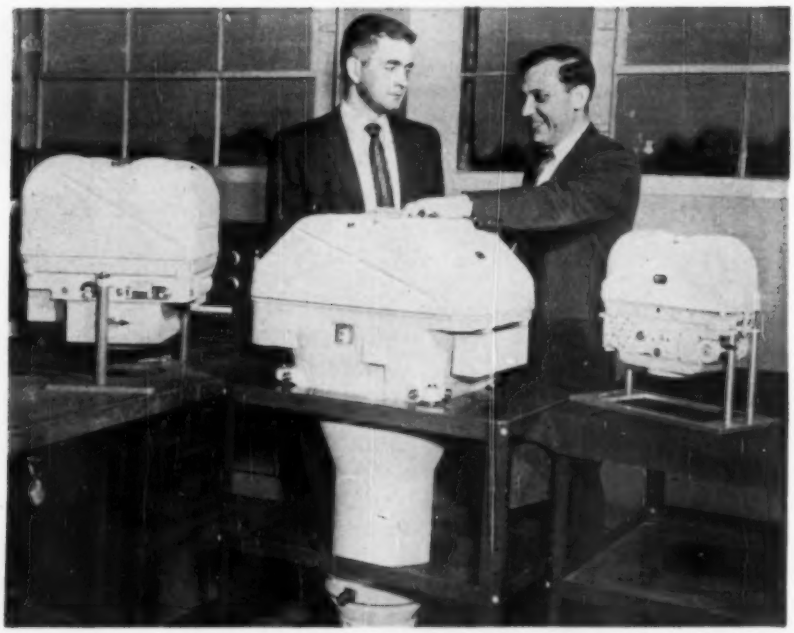
Fiat Jet Helicopter Model

At gross weight of about 3,080 lb., Fiat 7002 would have 83 mph. cruise speed, 186 mi. range, 138 gal. fuel capacity. Rotor diameter is 39 ft., fuselage length 20 ft. Aircraft would be powered by a 530 hp. gas generator that ejects compressed air at rotor blade tips.



FIRST DETAILS of photo-reconnaissance pods for Convair's supersonic RB-58 Hustler show two alternate installations. High-low camera group, No. 1, includes group of three 9 x 18 in. telephoto lens cameras (in middle of pod). Low camera group, No. 2, excludes these, uses five high speed, fast cycling 70 mm. cameras. Fairchild builds all cameras.

RB-58 Photo System Uses TV Viewer



THREE new cameras designed by Fairchild Camera for RB-58 photo pod include (left to right): KA-25, 9 x 9 in. general purpose charting unit; KA-27 9 x 18 reconnaissance camera; KA-26 fast cycling reconnaissance camera. Size and weight of all units have been reduced as much as 50% over earlier comparable models.

By George L. Christian

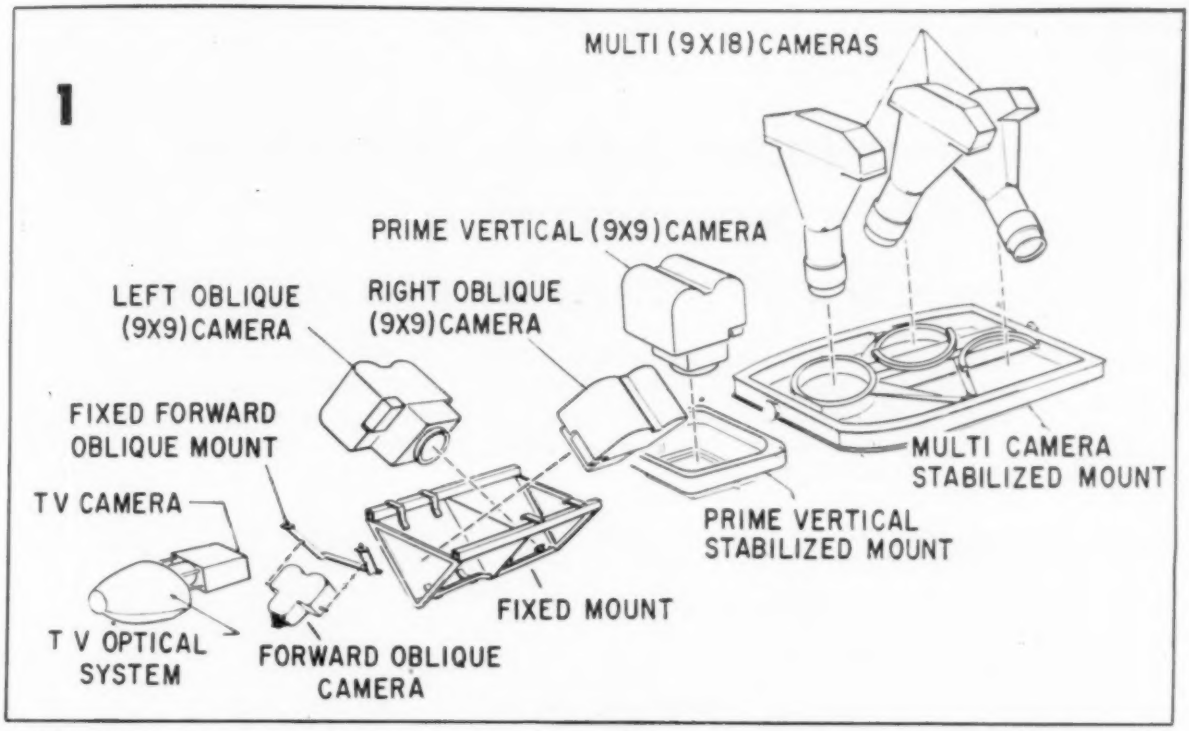
New York—First photographic reconnaissance system to be designed and built under the weapon system concept has been developed for Convair's supersonic RB-58 Hustler by Fairchild Camera and Instrument Corp. as major subcontractor.

Company is responsible for the complete airborne photo-reconnaissance and data recording system plus ground processing and support equipment.

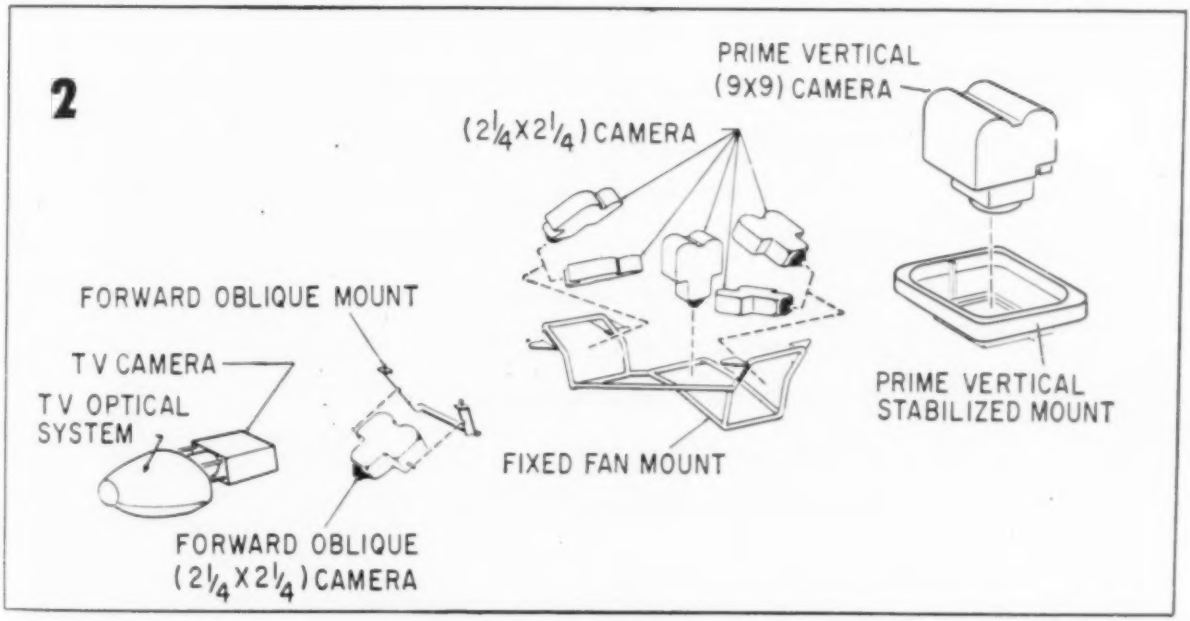
Fairchild Camera told AVIATION WEEK that it has just received a letter contract from Convair covering preproduction planning, tooling and limited procurement and fabrication of certain long lead items for the RB-58 photo-reconnaissance system. This will allow Fairchild to move into the production phase of the contract. Number of photo pods to be manufactured was not disclosed.

System is housed in the forward end of the large-size detachable pod carried by the Hustler, which can be interchanged for bombing or electronic countermeasures missions.

New features incorporated into the system include:



EXPLODED views show details of high-low altitude camera pod installation (above) and low altitude camera group (below).



• **All cameras** used in the system are new lightweight designs, built to operate at supersonic speeds at both extremely high and low altitudes.

• **Closed circuit** television is used in the system to provide the photo-navigator with unobstructed view of the terrain ahead of and beneath the plane in sufficient detail to allow him to identify landmarks and targets.

Operator can adjust television camera's line of sight in azimuth 45 deg. to either side of center and in elevation from zero deg. horizontal to 90 deg. vertical.

TV camera is equipped with two lenses, a standard unit with a 40 deg. field and a telephoto lens with a 10 deg. field.

Television system includes gyro-stabilized optics so that the horizon remains horizontal to the viewer regardless of the plane's attitude (within certain limits). Purpose is to avoid the confusion of a tilted presentation.

New Cameras

Three new cameras were designed by Fairchild for the system. There are:

• **KA-27, 9x18 in.** reconnaissance camera with telephoto lens. Camera includes Rapidyne shutter with continuously variable exposure times to 1/550th

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of a second, servo-controlled aperture settings from f. 8-f. 22 and a lightweight magazine with capacity of 500 ft. of standard 9½ in. wide aerial film. Camera and magazine weigh 75 lb. without film.

• **KA-25, 9x9 in.** general purpose charting camera. Unit includes Rapidyne shutter with speeds variable from 1/50th-1/700th sec., aperture settings from f. 6.3-f. 11 and a 500 ft. magazine for 9½ in. wide film. Camera and magazine weigh 51 lb.

• **KA-26, 2¼x2¼ in.** fast cycling reconnaissance camera. Unit includes simplified, high speed focal plane shutter with continuously variable speeds ranging from 1/1,000th-1/4,000th of a second and a fast 3 in. f. 1.5 lens.

Magazine accommodates 250 ft. of 70 mm. film.

Save Weight and Space

Special attention to detail and working under a weapon system concept enabled Fairchild engineers to reduce weight and space of the photo-reconnaissance system considerably over comparable, existing equipment. Company cites these examples:

• **Overall system** weight of 998½ lb. is 37% less than 1,584 lb. of a comparable, present day system. Weight of a typical 9x9 in. camera was cut by over half, going from 128 lb. to 50.7 lb.

• **Cubic content** of the system was shrunk from 114 to 65 cu./ft.

Fairchild said that, to reduce as much as possible malfunctions resulting from electrical connector failure, it cut number of connectors in the system from 92 to 23 and number of connector pins from 1,306 to 642.

Cameras can be assembled in the pod in two configurations, according to Fairchild, "hi-lo or low altitude, depending on the mission and flight plan."

• **Hi-lo altitude system** pod includes three KA-27 9x18 cameras contained in a single stabilized mount; three KA-25 9x9 cameras attached to a fixed oblique mount plus a third KA-25 in a vertical, stabilized mount.

Also included is a single KA-26 2¼x2¼ camera mounted in a fixed forward oblique position.

• **Low altitude system** uses but a single KA-25 camera and has five KA-26 2¼x2¼ cameras mounted fan-wise in a fixed mount plus the single KA-25 in the fixed forward oblique position. No KA-27s are used.

Automatic systems to operate and control the Fairchild photo reconnaissance systems for the RB-58 include:

• **Camera control system** which functions either automatically or manually from the remote control of the aircraft. Control system derives information from the B-58's navigation system to control camera drives so that all camera exposures are made to provide 55% overlap on each photograph for stereo viewing. System also synchronizes exposures of all cameras in each given group.

• **Automatic exposure control** selects shutter speed and diaphragm opening for each camera in the system, selecting the best combination for the type of film being used under existing conditions of light and aircraft speed.

• **Image motion compensation** which eliminates blurring the film due to plane's high speed by synchronizing movement of the film platen to forward motion of the aircraft.

• **Central data recording system,** containing a central time standard which provides a coded time base through which all other data is correlated. System can record all physical data required for future photographic interpretation such as velocity, altitude, Earth coordinates, weather and other required physical conditions.

Subsystem

Subsystem of the Recording System is a time index recording unit which automatically prints on photographs all pertinent data needed by readout devices used with the ground processing equipment tailored to the airborne system photo-reconnaissance system. This allows rapid processing and eliminates possibility of human error in hand titling.

Provisions are also made for a time index on the film in each camera to indicate time of each exposure to the nearest second throughout the reconnaissance mission.

Ground processing equipment developed by Fairchild to handle film exposed by the airborne system includes:

• **Special equipment** capable of automatically reading at high speed the recorded time base information for rapid correlation of individual photographs with associated physical data. Through use of related titling equipment, the film negative can be automatically titled so that intelligence operatives receive photos with all necessary correlation data printed on it with minimum delay.

• **Automatic, high speed film** and paper processors and printers for all sizes of film used with the system.

• **Special 35 mm. radar film** viewer-printer which allows an interpreter to look at an enlarged projection of selected frames, write the necessary annotations, then make both an enlarged print and a strip of edited, annotated radar film. This speeds processing of necessary briefing material and navigational data for the entire route to—and possibly from—target.

Fairchild Subcontractors

Fairchild subcontracted 41% of the program while retaining technical and managerial responsibility for design, development and coordination of all aspects of the photo recon system.

Fairchild subcontractors on the B-58 program are:

• **Norden Laboratories,** White Plains, N. Y.; television viewfinder equipment.

• **Aeroflex Laboratories,** Long Island City, N. Y.; camera mounts.

• **Eastman Kodak Company,** Rochester, N. Y.; photographic processing equipment.

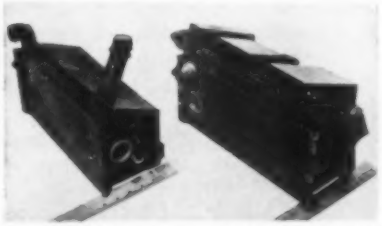
Liquid Heat Sink Handled as Solid

Development of a new evaporative cooling technique which allows a liquid coolant to retain its characteristics as a heat sink, yet be formed and handled as a solid, was announced recently by South Wind Division, Stewart-Warner Corp.

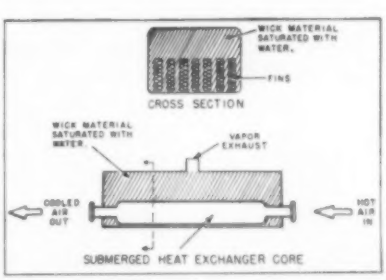
Key to the new concept, called "Liquid-Lock," is filling the heat sink with an inorganic wick material which retains 90% of its own volume of water. Wick, which is unaffected by fungi and has a temperature range of −65F to 290F, can be used with water, freon, ammonia, glycol and other coolants and allow 100% use of the latent heat of vaporization.

Advantages of the system are that it is smaller, lighter, simpler and cheaper than competitive heat sinks, according to South Wind.

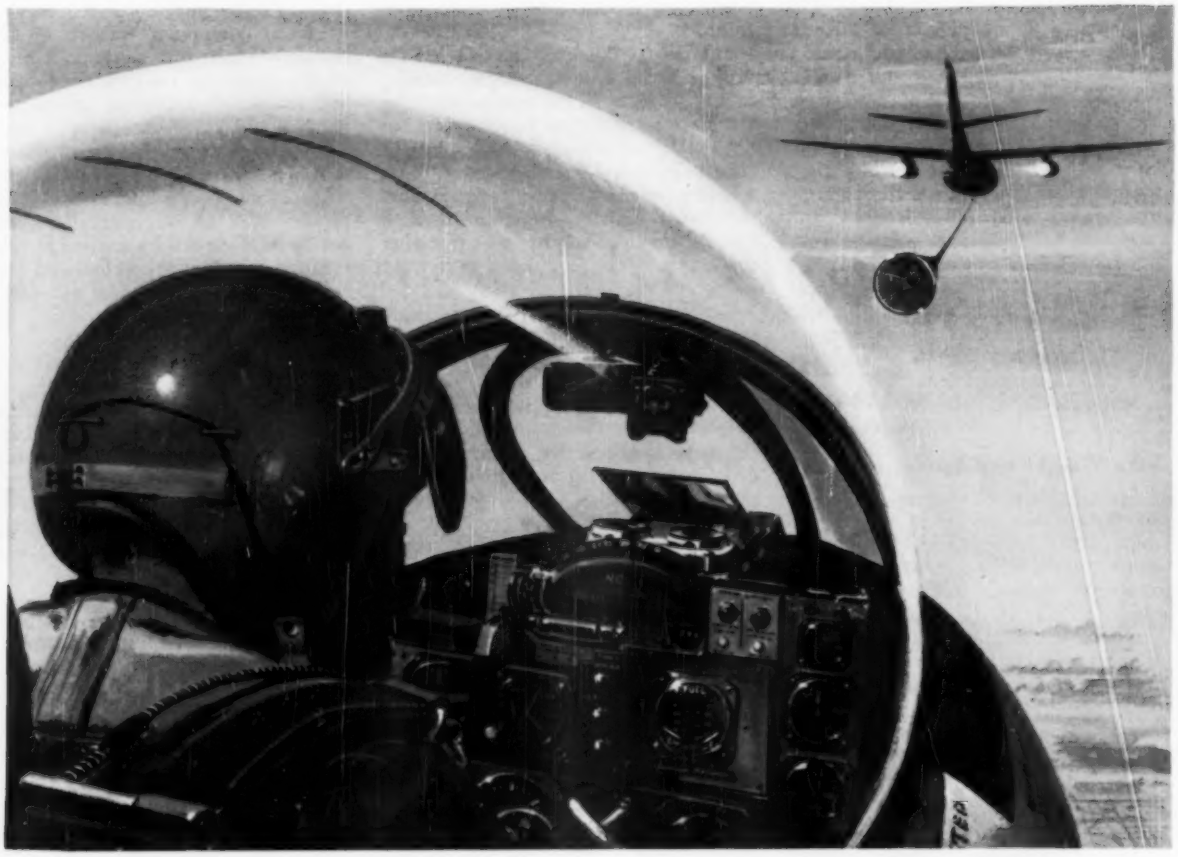
Liquid-Lock permits boiling or evaporation to occur without the use of baffles or valves to prevent spillage, regardless of attitude, yet allows vapors to vent without loss of fluid. Heat transfer surfaces are kept wet and efficient



LIQUID-LOCK unit at left is one-third smaller than conventional heat exchanger.



WICKING retains 90% of its own volume in water, resists high temperature effects.



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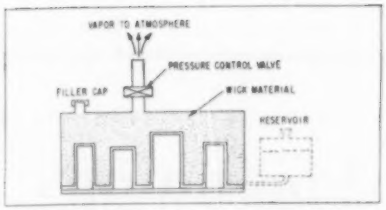

BOILING or evaporation can take place without spillage, regardless of attitude.

submerged. Boiling is attained without the problems of handling a free liquid.

Typical Comparison

South Wind cites this example as a typical comparison between one of its Liquid-Lock heat exchangers and a conventional water boiler heat exchanger. Both types of units are in production.

Requirement of both heat exchangers is to cool 8.2 lb. of air per minute from 290F to 115F at 60,000 ft. during a 13-min. period of extremely high speed. Water, using the submerged boiling principle, is the coolant.

The Liquid-Lock unit, compared to the conventional heat exchanger, is one third smaller in size, 10% lighter and is lower in cost, according to South Wind. Specifically, volume of the Liquid-Lock unit is 300 cu./in. compared to 450 cu./in. of the conventional unit and its weight is 5.25 lb. vs. 5.875 lb.

Additional advantage of Liquid-Lock is that, being a solid, the heat transfer surfaces are kept wet and therefore cooling takes place at all times regardless of acceleration, flight attitude or maneuvering of the aircraft. Loose coolant sloshes away from heat transfer surfaces during violent maneuvers, so that no cooling is provided at these times. Liquid coolant also presents the problem of spillage due to inverted flight or vibration, says South Wind.

Actual Applications

Actual Liquid-Lock applications, reported to be successful, include: cockpit cooling for fighter planes, component cooling for a jet airliner, cooling hydraulic and lubricating systems and cooling electronic gear, singly and in modules.

In addition to use in open water-boiling systems, potential Liquid-Lock applications listed by South Wind engineers include: freon system evaporators, condensing liquids, free water removal from gases, holding liquid rocket fuels, airframe panel cooling and commercial or household air conditioners.

South Wind says that further development work is underway on both an open type system, where vapor is vented to atmosphere, and a closed type system which normally is used in a freon cycle cooling system.

OFF THE LINE

New cryogenics test facility which will be used to check liquid gas (such as liquid oxygen) accessories used in rocket and missile systems is being erected by Sundstrand-Denver. Company plans to expand the plant for further development of hydromechanical components used on missiles. Facility is a division of Sundstrand Machine Tool Co., Rockford, Ill.

Bell Helicopter Corp., Ft. Worth, and G. F. Miles Ltd. of Great Britain have reached an agreement on the exchange of information on servo/electronic developments and visual presentation systems for helicopter simulators.

Seal for tapered roller bearings developed by the Timken Roller Bearing Co. is called "Duo-face." It combines features of an outside diameter seal and a face type seal. One lip fits in the bearing housing bore to provide an outside diameter seal. Other lip fits against the

flat, hardened and ground face of the bearing cup to give face type sealing. Seal is made of a synthetic material and its use does not require any special tools. Duo-face seals are available in these sizes: .750 in., .8437 in., 1 in., 1.250 in., 1.375 in., 1.5 in., 2.6875 in.

Large plant for producing Teflon tape and tape-wrapped wires and cables has been acquired in Winooski, Vt., by American Super-Temperature Wires, Inc. Full production has begun. Section of the new plant will be used for research and development on improved methods for producing Teflon insulated and unusual specification wires and cable.

Specially-designed plate and fin type aluminum heat exchangers will be furnished by the Trane Co. of Hamilton Standard Division of United Aircraft Corp. to be used in air conditioning equipment being built by Hamilton Standard for 48 Convair 880 jet transports now on order. Each 880 will be equipped with two identical 10-ton capacity air conditioning systems, one to condition the main cabin, the other to handle flight station cooling.

KITTY HAWK II

Since the mid-forties, top scientists in the United States have been working on the missiles problem. Would it surprise you to know that, in many divisions of missilry, we have out-distanced the Soviet?

At the moment this superiority may not seem important because of our "wrong alley" approach. Until Sputnik, we had been thinking of missiles as part of ordnance: ground to air or air to air defense weapons against invading aircraft.

Not so suddenly, the Soviet stole the march and invested missiles with an aura of finality, of ultimate scientific achievement.

We suggest that today's Thors, Vanguards, Jupiters, Titans and Atlases are, to the missiles age, what Kitty Hawk was to aircraft. New materials, new propellants, new IDEAS may shortly make 1958 models of missiles look like the Wright Brothers' plane.

Of this much we are sure. Aircraft and missile engines require formed and welded rings. If through some traumaturgy of modern science we should come up with revolutionary new designs, materials and methods, King will be in position -- because of its fortunate size and ability and experience -- to handle research commissions, pilot orders, to turn out small but important quantities. And when production runs come . . . King can handle them, too.

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CAB Accident Investigation Report:

Collision Emphasizes Visual Limitations

At approximately 1118,[1] Jan. 31, 1957, a Douglas-owned-and-operated DC-7B, N 8210H, and a USAF owned-and-Northrop-operated F-89J, 52-1870A, collided at 25,000 ft.[2] over the San Gabriel Mountains about three miles northwest of Sunland, Calif. The DC-7 crashed on the playground of the Pacoima Junior High School, Pacoima, Calif., killing three students and injuring 70 others. The four crew members, sole occupants of the aircraft, were killed. The F-89 crashed in the Verdugo Mountains southeast of the collision position, killing the pilot.

The radar operator of the F-89, though severely burned, parachuted to safety. Both aircraft were destroyed.

HISTORY OF THE FLIGHT

• **DC-7B.** On Jan. 31, at 1015, N 8210H took off from runway 3 of the Santa Monica, Calif., airport. The aircraft was a new DC-7B being flown for the first time for the purpose of functionally checking the aircraft and its components in flight following production. The flight crew members were Douglas Aircraft employes consisting of Pilot William G. Carr, Copilot Archie R. Twitchell, Flight Engineer Waldo B. Adams and Radio Operator Roy Nakazawa.

The aircraft had been subject to many regular inspections during its manufacture and numerous inspections which were required after production preceding the first flight. Accordingly, it was presumed the DC-7B was in airworthy condition.

Preparations for the flight by its crew were routine. Departure was on a local VFR flight plan filed with the operations office of the company. The plan showed six hours of fuel aboard and that the flight duration was estimated as 2 hr., 15 min. It also showed the gross takeoff weight of N 8210H was 88,000 lb., well under the maximum allowable. The load was properly distributed with respect to center of gravity limitations.

According to routine procedure the flight switched to the Douglas Co. radio frequency after takeoff and made periodic progress reports. At 1030 the crew reported over the Catallna intersection, 9,000 ft., routine, and thereafter, at 1106, over Ontario, 25,000 ft., routine.

At 1050 that morning, the Northrop-operated F-89J, 52-1870A, took off from runway 25 of the Palmdale, Calif., airport, accompanied by another F-89J, 53-2516A. The flight of 52-1870A was one of a series of functional flight checks following the completion of IRAN (inspection and repair as necessary), an overhaul project performed under contract by Northrop Aircraft for USAF.

The specific flight was in accordance with provisions of the contract and its purpose was to check the radar fire control systems of both all-weather interceptors. The two-member flight crew of 52-1870A consisted of Pilot Roland E. Owen and Radar Operator Curtiss A. Adams, both employes of Northrop.

Preparations for the operation were routine and departure was in accordance with a local VFR flight plan filed with the flight department of the company. The plan indicated the estimated duration of the operation as one hour with sufficient fuel aboard for approximately 1 hr. 45 min., considering afterburner time, altitude and power settings for the mission.

The F-89s took off individually, using afterburners, with a separation interval of 20 sec. In a wide starboard orbit the pilots utilized radar in a "snake climb" to 25,000 ft. At that altitude, a predetermined scissoring flight pattern was utilized which positioned the F-89s, without ground radar control, for simulated all-weather interceptor attacks on each other, during which the operation of airborne radar equipment could be checked. Radio transmissions, on company frequency, were recorded by ground facilities. These were routine commands between the pilots as they executed the radar check pattern and intercepts.

At 1118 activity in the Douglas radio room was interrupted by an emergency transmission from N 8210H. The voices were recognized by radio personnel familiar with the crew members. Pilot Carr first transmitted, "Uncontrollable." Copilot Twitchell then said, "We're a midair collision—midair collision, 10 How (aircraft identification using phonetic How for H) we are going in—uncontrollable—uncontrollable—we are . . . we've had it boy—poor jet too—told you we should take chutes—say goodbye to everybody."

Radio Operator Nakazawa's voice was recognized and he concluded the tragic message with, "We are spinning in the valley." This final transmission from the flight is presented because it contained important information relative to the accident investigation. It not only establishes the midair collision but also indicates the DC-7 was rendered uncontrollable. It further indicates that Mr. Twitchell at least recognized the aircraft with which they collided as a jet. Further, the DC-7 spun during its descent to the ground.

Weather conditions in the area at the time of the accident were reported by the Weather Bureau as clear, visibility 50 mi. Winds aloft at 25,000 were approximately 30 kt. from 320 deg.

INVESTIGATION

A committee, headed by Board investigators, was designated to obtain all pertinent information available from eyewitnesses to the collision. Among others, the most important objectives of the group were to obtain the place and altitude of the collision, the headings and movements of the aircraft prior to collision, the portions of the aircraft involved in the inflight impact, and the manner in which the aircraft descended to the ground.

Pursuant to these objectives it was learned that more than 140 persons had seen some phase of the accident, most, however, only that portion which followed the impact. About 115 of the known witnesses were personally interviewed and 106 formal statements were obtained from the total.

Witnesses Selected

From the interviews and statements, several representative witnesses were selected to testify concerning their observations at the Board's public hearing. The selections were made considering the aeronautical experience and background of the persons, the positions from which their observations were made, and how much of the accident they saw. Only a few saw the important phase prior to impact. All stated that clear weather conditions prevailed.

Of the witnesses who saw the aircraft before in-flight impact, a few were oriented or, by the nature of their work, were fully cognizant of directions. The preponderance of these witnesses stated that the DC-7 was on a heading of nearly due west and the F-89 was on a heading of nearly due east a few seconds before impact. They stated that the DC-7 seemed to be flying in a straight and level attitude.

The F-89 was also described by most as flying straight and level; however, a few thought it was turning left. None described any movements indicating either aircraft made evasive maneuvers to avoid the collision. They stated, however, that because of the altitudes variously estimated above 20,000 ft., it would have been difficult, if not impossible, to see any such movements. Neither aircraft was making a contrail which would have marked its flight path.

Smoke, Noise Noted

Nearly all witnesses stated a smoke cloud appeared in evidence of the in-flight impact and this was followed by a sound, resembling a clap of thunder. These were the factors directing the attention of most witnesses to the accident.

Eyewitnesses said that the DC-7 continued on a westerly heading for a short interval, then rolled to its left. As this occurred a plan view was afforded and several people noted that a portion of the left wing was sheared off. They also saw a shower of metal pieces near the smoke cloud reflecting the sun. The roll continued and the DC-7 entered an increasingly steep descent.

Several witnesses thought that the plane turned about its longitudinal axis during the descent and said that metal pieces con-

[1] All times herein are Pacific standard and based on the 24-hr. clock.
[2] Altitudes herein are mean sea level (msl).

tinued to break off in the area of the wing fracture. Numerous persons stated there was no fire but that white-gray smoke trailed from the wing fracture. Witnesses close to the crash site noted a general breakup of the aircraft before it struck the ground.

Witnesses stated that the F-89 emerged from the smoke cloud on an easterly heading. It burst into flames which enveloped the aircraft from its midsection rearward. While most witnesses said the aircraft did not spin, a few thought that it did. Most stated that the visible portion of the F-89 seemed intact, in that the wings and tip-tank-rocket pods were in place. The fall of the F-89 was described as a consistently steep trajectory.

Although the preponderance of witnesses who saw the F-89 before collision said it was headed easterly, many who saw it fall stated the trajectory was southeast. It was estimated that Mr. C. A. Adams, the radar operator, ejected from the aircraft about half-way down the descending arc of the jet.

The pilot of the F-89 that accompanied 52-1870A stated that the radar check flight had been entirely routine until the accident occurred. He stated that he and Mr. Owen had completed several simulated intercepts and that just before the accident each aircraft was being positioned for another. He stated that Mr. Owen's aircraft was to attack and his was to be the target.

Attack Simulated

At this time, according to the pattern, the interceptors were 15-20 mi. apart with Owen's aircraft on a heading of 135 deg. and his own on a heading of 45 deg. He explained that according to the procedure Mr. Owen would next issue a radio command at which time both pilots would execute standard bank 90-deg. turns: In the case of Mr. Owen a left turn to a heading of 45 deg., and in his own case a right turn to a heading of 135 deg.

In this manner, at the completion of the turns, the aircraft would be positioned so that Mr. Owen could proceed 90 deg. to the flight path of the target aircraft, commonly called the "attack vector." As the flights converged the radar operator of Mr. Owen's aircraft would locate the target plane on his radar scope and direct his pilot toward the target in a manner which would enable the pilot to simulate a firing pass.

The procedure required both aircraft to maintain 380 kt. true airspeed. He stated that the purpose of this type interceptor was to seek out an enemy aircraft by use of radar and destroy it in a weather situation which precluded positioning by visual reference. The witness explained that no feature of the radar ever flew the aircraft or took control from the pilot, it being designed to provide information to the pilot to enable him to maneuver into firing position.

He explained the "lock-on" phase was not a reference to control of the aircraft but meant that the radar was being directed to one specific target to the exclusion of all others.[a] He added that during this phase, target information was presented directly to the pilot on a small radar scope in his cockpit.

The pilot testified that Mr. Owen had given the signal for each pilot to begin his 90-deg. turn. This, he recalled, was, "Start making your ninety, now, Jim." He said that he immediately began his turn and would assume, according to regular practice, that Mr. Owen did too.

The pilot added that it was standard practice for the attacking pilot to transmit, "Steady on," indicating when the turn was complete.

He said that this transmission was not received and subsequent calls to Owen were not answered.

The witness said that he could not see the other F-89 at any time during this period and did not know the collision had occurred until notified by ground radio, which had intercepted the message from N 8210H. This occurred approximately one minute after the witness had finished his 90-deg. turn. Then, aware of a collision, he could only suspect that 52-1870A was involved.

Radar Man Busy

The radar operator who survived the collision stated that when it occurred he was checking a navigational feature of the radar equipment. The nature of the check required the radar search feature to be off. He said that he was not looking out but was looking at the equipment with his head lowered into a shield, "muff," which excluded most of the outside light.

He testified that he did not recall hearing the command to make the turns and to his best recollection the F-89 was on a heading of 135 deg., its true airspeed was 380 kt. and its altitude was 25,000 ft. when the impact occurred. The radar operator said the turn could have been started without his knowledge while he was concentrating on receiving the interrogator beacon signal in checking the navigational device. Also, because he was looking into the hood, without outside reference, a turn might not have been noticed.

He estimated that he was occupied with the check about 45 sec. He described the impact as being extremely severe but did not know whether it was a collision or an explosion. He said his cockpit was quickly enveloped in flames and his sole thought was to eject. This he accomplished quickly and with no recollection of the specific details.

The witness stated there was no fault with the aircraft operation prior to the accident.

Location Determined

A part of the accident investigation was devoted to determining as accurately as possible the geographic location over which the collision occurred. While eyewitness statements were being obtained, it was learned that a movie crew on location had accidently photographed the explosion cloud while shooting a western movie scene.

To facilitate retakes, and for other purposes, a feature of the camera used permitted putting exposed film in the camera and aligning it precisely with features on the film. Thus it was possible to insert a frame of film bearing the explosion cloud in the camera, place the camera in its original position, and align the topographic details on the film with the same details on the lens image.

After determining the elevation of the terrain (750 ft.), the height of the camera and other details, sightings were made using a surveyor's transit. Assuming the collision occurred at approximately 25,000 ft., it was calculated the accident occurred 5,000 ft. northeast of the Hansen Dam Spillway located between Pacoima and Sunland, Calif.

Because the distance between the camera and the accident was over 30 mi., the film, even when blown up to its maximum, did not show either aircraft or any detail of the collision.

During this phase of the investigation it was also learned that a surveyor, at work, had seen the collision. The witness stated that the next day he repositioned his transit and made bearings on the position of the explosion cloud position as he recalled it. Again assuming the collision was at 25,000 ft., results showed the accident took place over a position about 12,500 ft. northeast of the Hansen Dam Spillway.

From the results of both of these investigatory actions, together with considerable eyewitness testimony, it was determined that the accident occurred over an area northeast of the Hansen Dam Spillway, which is sparsely populated.

Following the midair collision, the DC-7 continued on a westerly heading for approximately four miles where it crashed on the grounds of the Pacoima Junior High School and an adjoining church.

Wreckage Examined

Wreckage distribution and the manner in which various components struck the ground made it clearly evident that the DC-7 sustained structural failure of its basic airframe during descent. A considerable number of major pieces from the tail surfaces and aft fuselage were recovered along a two-mile path ending just east of the principal wreckage area.

For the most part, pieces of the aft fuselage were closer to the principal area, showing this portion of the aircraft failed after the tail section. Portions of fuselage forward of the wing and just aft of the wing were located on the church property, indicating disintegration in this area prior to the initial ground impact.

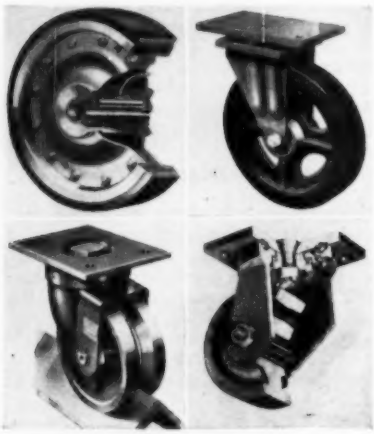
The major portion of the DC-7 fell on the school property and on impact it broke into numerous pieces, many of which were additionally damaged or destroyed by intense ground fires. Distinct craters were made by each of the four powerplants and the main wing center fuselage unit.

The wide separation between the craters compared to the normal distance between the components as installed on the aircraft showed these units had also separated from their supporting structure before ground impact. Characteristics of the craters, and the way debris was thrown out of them, showed clearly the units which made them were moving westerly.

Following the in-flight impact the F-89 fell southeastward for nearly 2½ mi. where it crashed on a narrow ridge in the rugged terrain of the Verdugo Mountains. Evidence showed the aircraft struck the ground relatively flat with a high sink velocity but

[a] An electronic device coupled to the pilot radar scope of F-89, 52-1870A, for the purpose of recording lock-ons, showed that 52-1870A had completed three. It showed no incompleted passes.

THERE'S NO SUBSTITUTE FOR DEPENDABILITY....



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little forward motion. The impact and an accompanying explosion caused extensive disintegration of the aircraft. An intense ground fire also completely or partially consumed many of the wreckage pieces.

During the structural investigation every effort was expended to determine, independent of eyewitness information, if there had been an in-flight collision between the aircraft and, if so, the manner in which it occurred. After the many scattered wreckage pieces were found, identified and their locations documented, they were transported to one location. There, the problems were approached by mockup, reconstruction, layout and isolation of pieces bearing collision evidence.

Collision Proof

This work disclosed and isolated areas of damage which, by their nature, conclusively prove that a midair collision did occur. Results of this work also provided the material for determining the physical relationship of the aircraft to each other at the instant of impact.

One of the most significant areas involved in the in-flight contact was the left wing of the DC-7, between stations 530 and 613. This area had been severely fragmented by impact forces with the largest single piece found about 18 x 12 in. in size. This piece and many others from the wing area were severely torn, crushed and curled. They also bore scratches and smudges associated with the collision contact.

Some of these pieces were recovered from ground positions below the previously described collision area considering the drift effect from winds aloft.

Outboard of station 613 to the wing tip, a span of about 8½ ft., the wing panel was recovered in one piece. This component was recovered in the Sunland area and was in a relatively undamaged condition. At the fractured inboard end of this piece the stringers and spar sections were crushed and deformed rearward.

On the bottom surface skin in the fracture area, scratches running aft and inboard were noted. Others were evident adjacent to the fracture with a few light smudges and scratches on the upper leading edge skin. Corresponding scratches were noted near the inboard end of a portion of aileron normally positioned on the wing in this area.

The average angle of the fracture, measured at the inboard end of this severed wing panel, was three degrees from a perpendicular to the centerline of the center wing spar. The aft end of the separation plane was farther inboard than its leading edge.

Wing Edge Deformed

At station 530 the leading edge wing skin was deformed rearward. There, additional scratches and black-gray smudges were noted. Between station 530 and the wing root there was no evidence of collision except minor deformation and a few grayish smudges at station 397 on the upper leading edge wing surface. Spectographic and microchemical tests identified these gray smears as paint, identical with samples taken from the F-89 horizontal stabilizer.

With respect to the F-89, it was learned it had fallen to the ground intact except for components which separated because of the inflight collision damage. This damage was obviously so extensive that continued control was impossible. Further, characteristics of fire damage showed the aircraft was afire during its descent to the ground.

Of equal importance to the structural objectives was the F-89 fuselage nose section rearward to about station 125. This area had sustained severe in-flight strike damage causing much of it to separate in flight as two large pieces and many fragments. One large section consisted of the upper panel structure above the nose section side doors from station 12,688 rearward to station 105. Below this panel structure an area the length of the panel and about 15 in. wide was gouged out. This area measured four degrees to the longitudinal axis of the aircraft with the aft end higher than the forward end.

A portion of the front nose circular ring was still in place at station 12 on the large nose piece. The ring was fractured 22½ in from the top centerline on the right side and 10 in. from the top centerline on the left side.

Measurements were made over the peripheral distance.

The second large piece from the nose section was from the area below the nose section side door between stations 12.688 and 105, or roughly the structure below the bottom edge of the gouged-out area. Similar to the upper nose section piece, this component bore in-flight impact evidence, had been torn off in flight and was recovered away from the main wreckage area of the F-89.

The bottom portion of the fractured circular nose section ring at station 12 was attached to this large lower panel section. A line joining the edges of the fractures of this ring on the lower section made an angle of about 29 deg. with a waterline plane, the right side being lower than the left.

Object Struck Nose

From the damage described and mockup reconstruction it was clearly evident that an object, about 15 in. deep, had passed through the F-89 nose compartment from front to rear at an approximate angle of 29 deg. The object passed through the Fiberglas radome, the nose frame at station 12 and through all intermediate frames and bulkheads rearward to and including station 105.

The F-89 radome was recovered in two large pieces. The separation line on these two pieces correspond approximately to the fractures in the circular nose section ring. The larger radome piece bore scratches in its black exterior paint and it was evident that they were made by a rivet line on the object which penetrated the entire nose section.

During the structural investigation considerable other in-flight impact and collision sequence evidence was found. Most, however, was cumulative in the principal areas already described or it was so inconsistent with the clearly established pattern that the damage was considered secondary.

It was also possible during the layouts, the reconstruction and isolation work to examine the individual pieces of wreckage which were not involved in the in-flight impact but which separated from the DC-7 before the ground impact. The characteristics of the various fractures clearly showed

that the general breakup of the DC-7 before ground impact was the result of airloads beyond the design or required strength of the airframe.

Such loads were undoubtedly imposed during unusual attitudes of the airplane in its fall.

This general disintegration, according to wreckage distribution, occurred shortly before ground impact and started with the empennage of the aircraft.

Engines Studied

An equally exhaustive effort was expended in examining the engines of both aircraft and, in the case of the DC-7, its engines and propellers. The objective was to determine whether or not any in-flight failure or operating difficulties of these components contributed in any way to the cause of the midair collision.

As indicated, the four DC-7 powerplants separated from the aircraft before ground impact as a result of excessive airloads. The units were severely damaged by this impact and were principally recovered from the widely separated craters in the schoolyard. In each case the propeller assemblies, nose, superchargers and rear accessory cases were broken from their respective power sections. All cylinders were broken loose from their power section. Numerous components from these assemblies were scattered forward of the craters for distances as great as 250 ft. There was no evidence on the engines of in-flight contacts.

Following a preliminary examination at the wreckage site, the powerplants were removed to suitable facilities for disassembly and detailed examination. This showed the various gear trains, bearings and shafting of the engines had been normally lubricated prior to impact and that there was no evidence of failure or operational distress.

Boroscopic examination of the cylinders revealed no indication of combustion irregularities. The articulating assemblies of the engine showed no evidence of operating distress and the oil pumps and screens were free of foreign material. While all of the engine accessories were recovered, ground impact damage precluded them from being functionally checked.

DC-7 Propellers

The DC-7 propellers remained tight on their shafts; however, each assembly, as indicated, was broken from its engine. The propeller blades exhibited various degrees of camber and face-side bending. Careful examination of the propeller blades, especially of the No. 1 and 2 engines, showed clearly they were not involved in the in-flight collision.

Examination of the propeller pitch-changing mechanisms disclosed the stop rings properly indexed for a blade range of 54½ deg. positive, full feathering, and minus 14 deg. reverse. Impact markings on the spider shims and shim plates revealed a propeller blade angle at ground impact averaging 58.5 deg. Because of the in-flight disintegration of the aircraft and separation of the powerplants, as well as possible throttle manipulation during the descent, little significance can be attached to this evidence with respect to power or airspeed at the instant of collision.

The turbojet engines of the F-89 were recovered in the main wreckage of the aircraft.

Both were heavily damaged by ground impact and fire after impact. Some portions of the engines were hurled 4,000-5,000 ft. from the crash site. The inlet and accessory sections of both engines were broken off and consumed by fire. The first three stages of the left engine compressor and the first stage of the right engine compressor were broken away.

Variable bending and lack of damage to some blades in the same stages were indications that the damage was the result of impact with the ground. The combustion cans, although deformed, showed no indication of overheat. Crossover tubes were normal. Both turbine assemblies were intact but displaced rearward. The aft sides of the turbine wheels were freshly scored, indicating rotation when the wheels were forced rearward.

From the investigation of the powerplants of the DC-7 and the engines of the F-89 there was no evidence found to indicate that a malfunction or failure of any of these units was a factor in the accident.

DC-7 Status

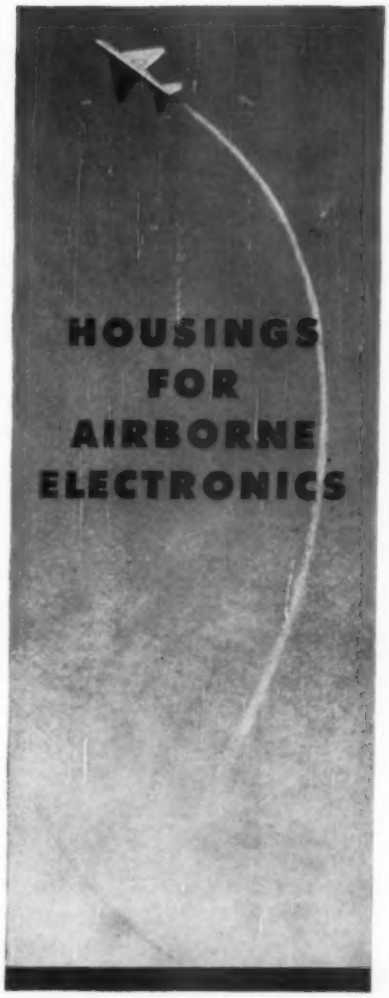
Because of some misunderstanding during the accident investigation, the Board believes it is in the public interest to explain the status of the DC-7, the nature of its first flight and the requirements and restrictions associated with the operation. These subjects were fully explored during the public inquiry through witnesses representing the Douglas Co. and the Civil Aeronautics Administration.

From inception of an air carrier-type aircraft to commercial production of the model many months, or years, of design, evaluation and tests are required. During this period after the model is produced it is an experimental aircraft and may be flown only under an experimental certificate issued in accordance with Civil Air Regulations by the CAA. This strictly limits operation of the aircraft in the interest of safety.

During this period the model must exhibit, through every manner and type of test, its strength, safety, performance and quality, and meet or exceed the standards required by appropriate Civil Air Regulations. On completion of this work, if the airworthiness is proved, the model is awarded a type certificate and may be duplicated in exact kind and quality for commercial sale. N 8210H was such a duplicate, one of over 300 already manufactured and in use in commercial aviation.

The manufacture of such aircraft under type certification is closely supervised by CAA personnel. This is a form of quality control and accomplished by inspection and tests performed regularly and frequently throughout manufacture. When production is complete, numerous additional checks are accomplished by the manufacturer, and in the case of N 8210H nearly 15 hr. ground time were accumulated on the powerplants during this work.

Before a formal airworthiness certificate is issued for the individual aircraft, Civil Air Regulations require that a functional in-flight check be accomplished. This is principally a flight to gather information from which, if necessary, final and minor adjustments on the aircraft and its com-



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ponents can be made. Accordingly, N8210H was being flown for this purpose when the subject accident occurred.

Flight Limitations

The functional check flight is made under a special flight authorization certificate issued by the CAA and it also is restrictive. Among other limitations, the aircraft must be flown in visual flight rule weather conditions, without passengers and, except for landing and takeoff, the operation must be over sparsely populated areas.

The F-89 was produced in a similar manner; however, the standards and specifications of a military plane are governed by the military establishment and not by Civil Air Regulations.

The IRAN project, in the case of the F-89, was principally a complete overhaul of the aircraft. This in no manner changed the basic proven airworthiness of the aircraft; however, such projects may modernize some of its components, especially those relating to its weapon equipment.

Northrop records showed that after the overhaul work was completed with respect to 52-1870A, the aircraft had been flown six times for various checks of the work performed. The subject flight was to be a final check by the Northrop Co. before turning the aircraft back to USAF. It was for the purpose of checking the radar portion of the weapon systems of the aircraft and thus was a functional check flight.

In accordance with Air Force regulations pertaining to the Air Force flying activity at Palmdale, which were mutually agreed upon and part of the Northrop operating procedures, the F-89 flights were not to be made over congested areas except during landings and takeoffs. Also, the flights were to be conducted within an area generally bounded by San Diego, northwest to Santa Barbara, northeast to Bakersfield and southeast to El Centro.

As a standard Air Force requirement this area was designated and published as a local flying area; however, such did not set it apart for the exclusive use of the company.

As a matter of fact, the same area is used in the flying operations of the numerous aircraft manufacturers located in the Los Angeles vicinity.

Witnesses stated the joint use of this airspace was common knowledge. They also said it was heavily used by the aircraft of the manufacturers, the military and commercial traffic serving the large metropolitan area. Further, the space was limited by restricted areas bordering the aforementioned local flying airspace on the east and west sides. The accident occurred within this local flying area.

VFR Flights

It will be recalled that both flights were operated under local VFR flight plans. Accordingly, the avoidance of other aircraft was a direct responsibility of the pilots of both aircraft. Civil Air Regulations, Part 60, Section 60.12(c), clearly place this responsibility on all pilots, regardless of the type aircraft. Rules for avoidance and right-of-way are also spelled out in these regulations, Section 60.14(a) through (c) and Section 60.15.

Because of this pilot responsibility it was considered important to determine what, if any, effect the operational nature of the flights had on the ability of the pilots to carry it out. Specifically, it was important to learn whether or not the operational nature of the flights required an unusual amount of pilot cockpit preoccupation. Witnesses, well qualified through actual experience in performance of the flights, were questioned with respect to this subject.

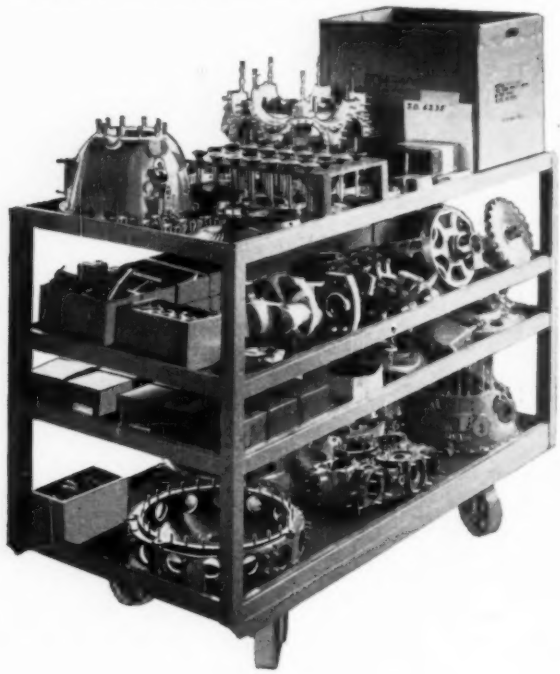
A Douglas representative described the production flight check from its beginning to end, stating that each was very similar and followed a definite pattern. He stated the purpose was a thorough operational check of the aircraft, its powerplants and its equipment involving flight at various power settings, aircraft configurations, all at various altitudes.

Itemized Checklists

The witness testified that flight check sheets are carried aboard the flights and the items are accomplished in the sequence of their arrangement on the sheets. He also said that as the flight progressed and the items were accomplished, the results were recorded. This duty, he said, was exclusively a responsibility of the flight engineer.

He also said the manipulation and setting of controls, except flight controls, was principally done by the flight engineer. He concluded that there was no greater pilot cockpit preoccupation in this type of operation than in any other.

During the investigation these flight check sheets were recovered from the wreckage of N8210H. It was noted that many of the



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MICRO-BEARING ABSTRACTS

by **A. N. DANIELS,** *President*
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CONTACT ANGLE

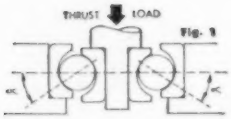

Fig. 1

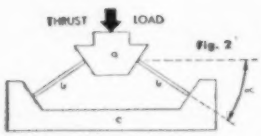

Fig. 2

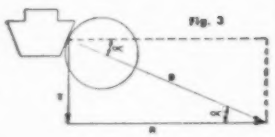
Fig. 3

Contact angle is the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where the ball makes contact with the raceways when the bearing is subjected to a pure thrust load. In *Fig. 1*, the contact angle is represented by angle α. The significance of the contact angle is revealed by an examination of the forces present in a thrust loaded bearing.

In *Fig. 2*, a simplified version of *Fig. 1*, the shaft and inner ring combination are represented by the plug *a*, the "working diameters" of the balls and represented by the rodlike members at *b*, and the outer ring is represented by the tapered cup *c*.

The contact angle is α. This diagram represents a three-dimensional structure with as many equally spaced rods, *b*, as there are balls in the bearing.

The primary concern in design is the amount of compressive force to which rod *b* is subject, which is the force with which a given ball is pressed against the raceways. This force can be calculated by constructing a parallelogram of forces as shown in *Fig. 3*.

The sides T and R, are vector quantities, and diagonal B is the vector sum of T and R. Furthermore, the vector sum of the thrust components on all the balls equals the total thrust load on the bearing. The vector sum of the radial components on all the balls is zero. Vector B, the force actually felt by the raceways and balls, compared to vector T, the thrust component, varies significantly with changes in the size of the contact angle and is directly proportional to the thrust load component and inversely proportional to the sine of the contact angle.

Example I:

A bearing is carrying a pure thrust load of 21 pounds. Assuming seven balls in the bearing, each ball will have an axial load component of three pounds, since a thrust load is shared equally by all the balls. While the axial component on each ball is only three pounds, the actual compressive force, or squeeze, felt by the ball and raceways is considerably greater than this value.

With a contact angle of five degrees:

$$B = \frac{T}{\sin \alpha} = \frac{3 \text{ lbs.}}{\sin 5^\circ} = 34.5 \text{ lbs.}$$

Thus we see that with a five-degree contact angle the actual load felt by each individual ball is actually considerably greater than the total 21 pound thrust load on the bearing.

Example II:

Using the thrust conditions in Example 1, the contact angle is increased to 20 degrees, by selecting a bearing with a larger value of radial play.

$$B = \frac{3 \text{ pounds}}{\sin 20^\circ} = 8.78 \text{ pounds}$$

A 15 degree increase in contact angle produced a 74.5% reduction in ball-to-raceway contact stress. This relationship should be noted by anyone who writes bearing specifications. The operational qualities of the bearing, such as low running and starting torque and bearing life, are a function of the ball-to-raceway contact stress. Thus the contact angle is highly significant.

It is not necessary for a bearing user to calculate or specify the contact angle desired. It is only necessary to remember that low values of contact angle are associated with low radial play, and high values of contact angle are associated with high radial play. In addition to the above considerations, gyratory forces become extremely important factors in determining optimum contact angle in high speed applications.

A more complete discussion of contact angle is found in our design handbook.

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items had been completed and in sequence. The end of the completed items indicated that when the collision occurred the aircraft was being flown at 25,000 ft. and at about 330 kt. true airspeed, for the purpose of checking carburetor operation at maximum cruise power. A study of the writing showed clearly it was in handwriting of Mr. W. B. Adams, the flight engineer.

Witnesses experienced in the F-89 radar check flight operation stated it required precision flying and that accuracy of headings and altitudes was required within narrow tolerances. Because of this the simulated intercepts were usually flown using autopilot. Witnesses familiar with Mr. Owen's technique believed he would have been using it continuously during the radar pattern and simulated intercepts which would include the turn preceding the attack vector. The radar operator could not tell from his cockpit. The witnesses testified that using the autopilot provided the precision necessary and greatly reduced the pilot's concentration within the cockpit.

Testimony indicated that during the turn preceding the attack vector the pilot had only to monitor the turn. During this time there was nothing connected with the radar equipment to occupy his attention. Greatest cockpit concentration on the pilot's part would be later during the lock-on phase of the intercept which follows completion of the turn to the attack vector and after the search phase has been accomplished.

Witnesses concluded that during the positioning turn Mr. Owen would be free to look out for other aircraft. As previously stated, the responsibility to look out for other aircraft was in no manner reduced by the designation of a local flying area.

ANALYSIS

The several areas of primary collision damage and markings furnished the foundation for a successful analytical study of how the in-flight collision sequence occurred and the relative attitudes of the aircraft at impact.

Initial contact occurred when the leading edge of the left wing of the DC-7 between stations 530 and 613 made contact with the Fiberglas radome of the F-89. As the two aircraft passed, the left wing of the DC-7 and nose section of the F-89 progressively penetrated one another until the left wing outboard of station 530 was sheared off and the nose section rearward to station 125 was destroyed. Impact markings made during this sequence showed clearly that the aircraft were rolled 36 deg. to the left with respect to each other.

As the split second sequence continued, the left horizontal stabilizer of the F-89 brushed across the upper surface of the DC-7 left wing at station 397 leaving paint smudges in that area. The relative angle in the roll plane between the aircraft and location of the stabilizer brush marks showed the F-89 would clear the No. 1 propeller arc of the DC-7, thus accounting for the absence of propeller cuts and blade damage.

The aircraft then passed one another and from all the available evidence there were no other primary contacts between them. Damage received by the F-89 clearly showed it would have been rendered uncontrollable. In the case of the DC-7 it is doubtful that effective control would have existed, the latter substantiated by

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the final transmission from its crew, "Uncontrollable."

The relative angle between the aircraft in the pitch plane must be deduced from the impact markings and the existing angles of attack of the aircraft when the marks were made. Impact damage was all predominantly rearward and slightly inboard on the DC-7 with little or no upward or downward indications.

On the F-89 the damage was rearward with a four-degree upward angle. With respect to airspeeds, a principal consideration in determining angles of attack, ample evidence indicates that the true airspeed of the F-89 was 380 kt. and, though less conclusive, it is quite probable that the true airspeed of the DC-7 was 330 kt. Considering this evidence, it is very reasonable to conclude that both aircraft, relatively, were level in the pitch plane.

Impact Angle

The impact angle in the yaw plane is perhaps the most important factor of the collision orientation because it is most indicative of the converging flight paths before impact. This angle is based on considerations of airspeeds and the fracture angle of the cut on the left wing of the DC-7, which was measured as three degrees inboard from front to rear. Accepting the airspeeds mentioned and the angle of the cut, the resultant angle of convergence was about five degrees from head-on.

As previously indicated, the correlation of physical damage, collision marks and impact angles relate one aircraft to the other but not with respect to the ground. It is therefore necessary to deduce the orientation with respect to the ground through other means.

While direction of flight at impact may often be indicated by the direction of wreckage scatter, in the subject accident this was not definitive. Thus, orientation of the aircraft with respect to the ground and the direction of flight of the aircraft at impact are necessarily based on the observations of eyewitnesses and some circumstantial evidence.

The preponderance of eyewitnesses, some aeronautically qualified and cognizant of direction, believed that the DC-7 was heading about due west and the F-89 was heading approximately due east when they collided. While it is possible that some error may exist in these collision headings because of the difficulty of such estimates from ground positions, it is noteworthy that only substantial errors would have an appreciable effect on the results based on them.

Recalling it was Pilot Owen's intention to turn left from 135 deg. to 45 deg. using a 30-deg. bank, and accepting the collision headings as substantially correct, it is entirely reasonable to conclude that the F-89 was banked to its left about 30 deg. with respect to the ground when the impact occurred. This conclusion would thus place the DC-7 flying straight and level, or nearly so, when the two aircraft collided.

In summary, based on all the available evidence, it is the judgment of the Board that this collision occurred nearly head-on while the DC-7 was flying straight and level, or nearly so, on an approximate westerly heading. It is believed that it occurred while Pilot Owen was executing a level left turn from 135 deg. toward an anticipated heading of 45 deg. and that his aircraft was banked approximately 30 deg. It is also clearly evident that the accident took place in clear weather conditions at 25,000 ft. over a noncongested area between one and two miles northeast of the Hansen Dam Spillway.

The small difference between the standard bank of 30 deg. and the 36-degree impact angle in the roll axis cannot be positively explained. It is possible, however, that this six-degree difference is indicative of the start of an evasive maneuver. From the transmission by Mr. Twitchell, "Poor jet too," it is known that he saw the F-89. Because the collision sequence occurred in about 1/100 of a second he could not have recognized the aircraft as a jet at that time and must have done so before impact. It is possible, therefore, he saw the jet in time to react and start a left bank which had progressed six degrees but which was insufficient to avoid the collision.

In order to evaluate the all-important question of whether or not the crews could have seen and avoided the collision, an analytical study of the opportunities was made. The aforementioned collision factors were applied, with others, such as closure speed, visual range and angular position of the conflicting aircraft on the other's windshield. It must be realized that some of these latter factors are the products of numerous considerations.

Distance Limitations

The maximum distance that an aircraft can be seen depends upon its angular presentation, its color contrast with the existing background as affected by the degree of illumination, and the atmospheric conditions of visibility including altitude effect. These factors are highly variable and different in each actual situation, and small amounts less than optimum in the conditions result in an appreciable reduction of the maximum distance that an aircraft can be seen. Also, it is known that the head-on or near head-on flight paths are the most unfavorable situations for sighting other aircraft because of the relatively small frontal profile presented during closure.

Realizing the intangible nature of the maximum sighting distance, the Board carefully considered each factor, together with published material on the subject, and selected 3.5 mi. as its best estimate.

Accepting this distance and applying it to the flight path portion of the analytical study, the F-89 would enter visual range about five deg. to the right of zero reference on the DC-7 windshield. Movement during closure would be slowly from right to left until just before impact. At visual range the DC-7 would be positioned 22 deg. to the left of zero reference on the F-89 windshield.

Considering the banked attitude of the F-89, this initial position would be on the canopy glass off the armor-glass windshield. Movement of the DC-7 during closure would be slowly diagonally downward from left to right until just before impact.

Considering the probable flight path of each aircraft to collision, the visual range and the true airspeeds of the aircraft, computations show the closure speed between them was about 700 kt. The calculated time from visual range to collision was about 15 sec.

While a conflicting aircraft is within visual range it must first be detected by the pilot, then an avoidance decision must be made and, finally, the aircraft must respond to and carry out the avoidance maneuver. Each of these factors requires an element of time, the total of which must be sufficient for a successful collision avoidance.

Detection of another aircraft is probably the greatest time-consuming factor, being restricted by physiological limitations of the human eye. The eye will best detect an object when it is within the focal field of vision, some 2-3 deg. wide. With sufficient motion the object may be detected within the peripheral field, a few degrees outside the focal area. To compensate for these restrictions the pilot must employ scanning to search the broad areas of potential collision to detect other aircraft. Thus, a reasonable opportunity to avoid collision must include a reasonable time for detection.

Following detection, the pilot must then evaluate the situation and determine if collision courses exist and, if so, decide on the proper evasive maneuver. The time required for such decision may vary.

For example, it may be hard to determine whether or not a conflicting aircraft is approaching or moving away. It may also be difficult to decide which way a turning aircraft is progressing and where its projected flight path will take it from its sighted position. This is especially difficult when the conflicting aircraft and the aircraft from which it is viewed are being flown at high speed.

Aircraft response, especially for the large transport type, is less than immediate. Although with boosted controls the attitude of the aircraft may be altered rapidly, several seconds are required before the direction of flight is sufficiently changed.

Minimum Time

Considering these collision avoidance elements and all the available evidence, it appears that only the minimum time opportunity existed for the pilots to have carried out the basic elements of collision avoidance. It is clear that only if the pilots sighted the other's conflicting aircraft early in the period when it was visible and took immediate evasive action could the collision have been avoided.

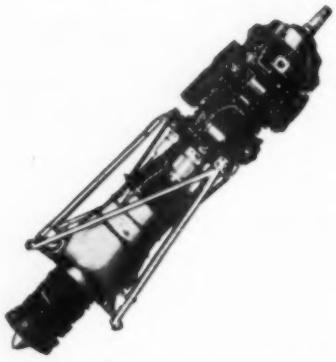
Thus, it is the considered opinion of the Board that, while visual separation could have been effected in the time available, because of the near head-on closure and the high rate of closure at high altitude the pilots were confronted with unusually great problems of visual separation.

The accident, which appears to have occurred under almost the most adverse conditions insofar as the time opportunity for the pilots to see and avoid is concerned, raises the question whether the long established "see and be seen" philosophy applicable to VFR flight is adequate in uncontrolled operations.

It is clear that, under certain conditions of speed and angle of convergence, very little time opportunity exists for pilots to observe the other aircraft and take avoidance action. As aircraft speeds and traffic density increase, this problem will be aggravated.

While this problem is serious, and grow-

ELAND (for fixed wing aircraft) propeller-turbine engine for new airliners and conversion of piston engine airliners to propeller-turbine power. Chosen for the Hamburger Flugzeugbau C209 and the Convair 340.



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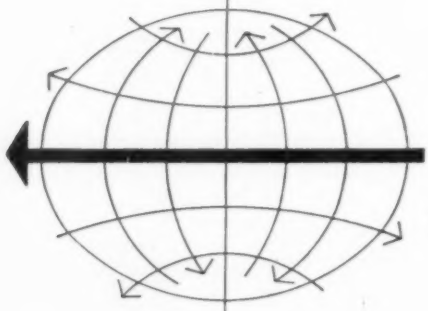

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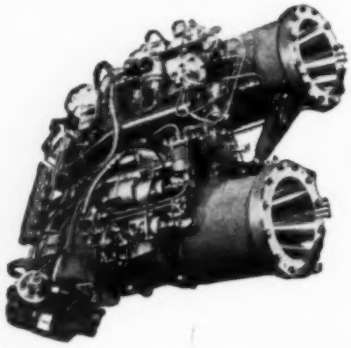

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ing more so, it is not sufficient cause to discard the see and be seen rule. Alternative to this fundamental rule in VFR operations either do not exist as yet or are so extreme that they would penalize the expeditious flow of traffic to the point where aircraft operations in general would be stifled.

For instance, the practical consequences of immediate implementation of full positive control for such operations regardless of weather would be the grounding of a large percentage of current aircraft operations.

Therefore, until technological advances are made which will insure separation of aircraft without reliance on the vigilance of the pilot, the Board will continue to rely on the see and be seen policy with whatever refinements circumstances and the state of the art permit.

In this connection, the Board calls attention to certain regulatory amendments already adopted and others in preparation which serve to refine the see and be seen rule in the light of high-speed, high-performance aircraft operations. In this group are the pilot vigilance and restrictions on flight testing rules; the VFR minimums within control zones for flights with traffic clearance, and speed control and communication rules in high density air traffic zones; the high altitude quadrantal rules; and the continental control area rules.

In view of the foregoing, the Board must call to the attention of all persons engaged in the operation of high speed aircraft that the closure rates of such aircraft in normal operations impose obligations for vigilance on the part of operating crews which are of extreme urgency.

We are faced with no immediate alternative but to seek the redoubling of effort on the part of management and operating crews to prevent any avoidable diversion or preoccupation which would tend to compromise the ability of pilots to see and avoid other aircraft.

It has not been possible in this instance to determine specifically what had prevented the crews of either aircraft from taking timely action; however, we conclude that the avoidance of collision by visual means was not beyond the physical capabilities of the pilots involved provided full attention was given to collision avoidance.

Accordingly, reliance must continue to be placed upon pilots of aircraft engaged in similar operations to provide for separation under visual flight rules. To this end, however, the Board will continue to review in-flight procedures, cockpit design including instrument and equipment layout, aircraft crew complements, and the training and indoctrination of flight crews to insure that the possibility of recurrence of such a collision is minimized.

FINDINGS

On the basis of all available evidence the Board finds that:

1. The aircraft and the crews were properly certificated according to the status of the aircraft and nature of the operations.
2. Preparation for the flights was complete and routine.
3. The flights were operated in clear weather conditions and in accordance with the provisions of local VFR flight plans.
4. Under VFR weather conditions and

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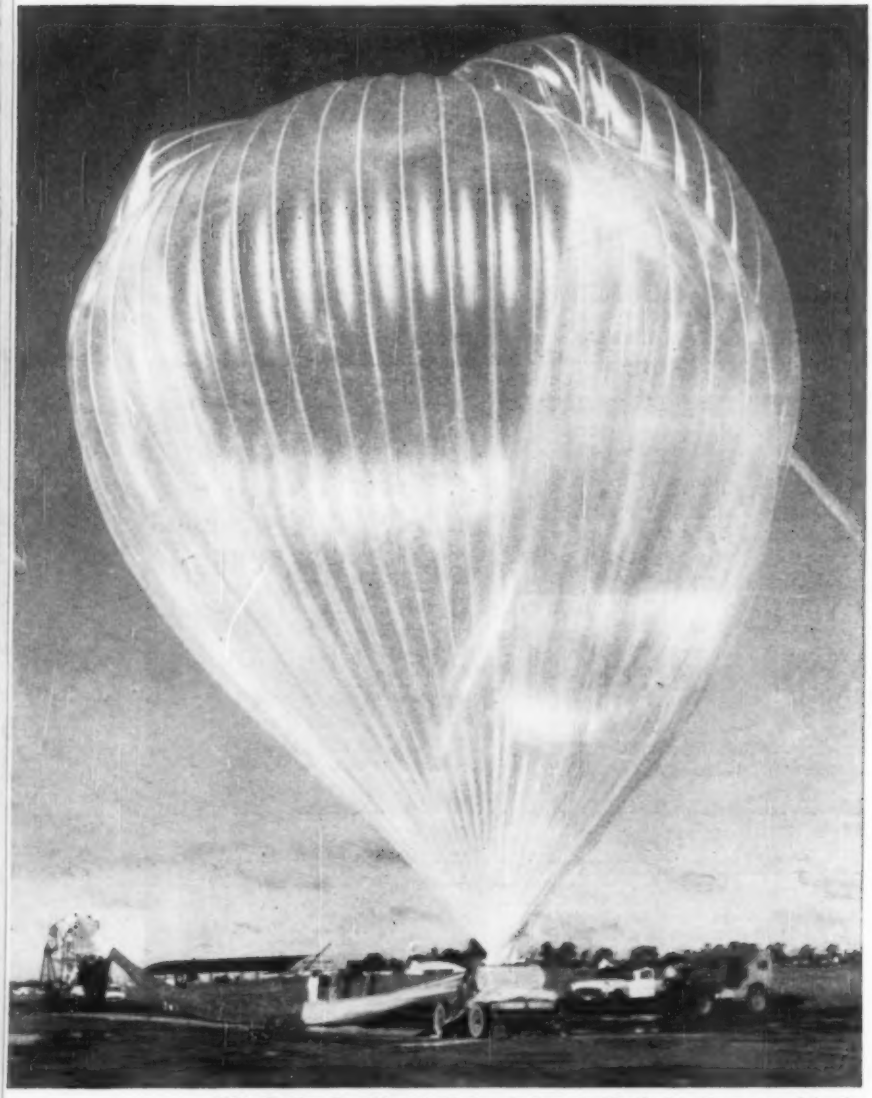

This Project Farside polyethylene balloon is identical to the one used in the actual rocket flights. Here it is being readied for a test ascent. Its load is an exact replica (size and weight) of the platform and rockets which were carried to 100,000 feet at Eniwetok Atoll.

In Project Farside, General Mills' polyethylene balloons like this, the largest ever flown, lifted a series of rockets 100,000 feet above the earth. (The nearly 4,000-pound loads were the greatest ever carried to that height.) With 98.7 percent of the drag-producing atmosphere already behind them, the rockets could then be sent farther out into the unknown to gather scientific data essential to man's mastery of space.

Unusual projects of this type are a specialty of the complete balloon systems group at General Mills. The complete package includes balloon and instrument design and manufacture, launching and recovery services, weather forecasting and data reduction.

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VFR flight plans collision avoidance rested in visual separation, a pilot responsibility.

5. The DC-7 and F-89 collided in flight on approximately west and east headings, respectively. They were at 25,000 ft. over a noncongested area between one and two miles northeast of the Hansen Dam Spillway.

6. At impact the F-89 was rolled about 30 deg. left, both aircraft were about level in the pitch plane, and the convergence angle was about five degrees from head-on.

7. Both aircraft fell out of control and the DC-7 crashed in a populated area.

8. From visual range, estimated at 3.5 mi., the closure speed between the two aircraft was 700 kt. and over the probable flight paths the time to collision from visual range was about 15 sec.

9. The nature and purpose of the flights did not prevent all pilots from maintaining a lookout for other aircraft.

10. There was no evidence found to indicate that any malfunction or failure of the aircraft or their components was a factor in the accident.

PROBABLE CAUSE

The board determines that the probable cause of this midair collision was the high rate of near head-on closure at high altitude which, together with physiological limitations, resulted in a minimum avoidance opportunity during which the pilots did not see the other's aircraft.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti
Louis J. Hector

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident through its Santa Monica office a few minutes after it occurred. Investigators were promptly dispatched to the scene and an investigation was initiated and conducted in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and held in the Hollywood Roosevelt Hotel, Hollywood, Calif., last Mar. 20-21.

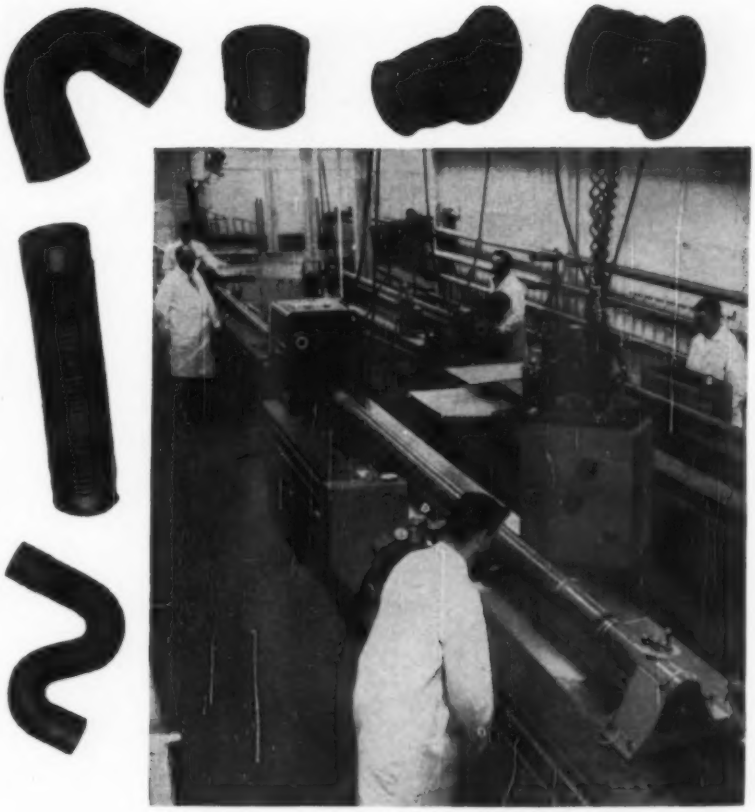
The Douglas Aircraft Co., Inc., a Delaware corporation, has its principal offices in Santa Monica, Calif. The company is principally engaged in the manufacture of aircraft.

Northrop Aircraft, Inc., a California corporation, has its principal offices in Beverly Hills, Calif. The company is principally engaged in the manufacture of aircraft.

FLIGHT PERSONNEL

1. Douglas. Pilot William G. Carr, age 36, was employed by the company on Jan. 14, 1952. He held a valid airman certificate with an airline transport rating and rating for the subject aircraft. He also held numerous other type ratings as well as ratings on airframes and powerplants. Pilot Carr had 11,757 total flying hours, of which 598 were in the DC-7 type. His last medical examination was accomplished Nov. 27, 1956, without waivers.

Copilot Archie R. Twitchell, age 50, was



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employed by Douglas since Feb. 2, 1955. He held a valid airman certificate with airline transport and DC-7 ratings. The pilot had accumulated 7,115 flying hours, of which 287 were in the DC-7. His last medical examination was accomplished, without waivers, on Feb. 9, 1956.

Flight Engineer Waldo B. Adams, age 43, was employed by Douglas Jan. 4, 1937. He held a valid airman certificate with flight engineer, airframe, engine, and commercial pilot ratings. Company records showed he had accumulated 2,711 flying hours as a flight engineer, of which 278 were in the DC-7 type aircraft. He had taken his last physical examination on Feb. 22, 1956, and it was accomplished without waivers.

Flight Radio Operator Roy Nakazawa, age 29, was employed by the company May 26, 1952, and held the position of a flight line technician (electronics). Mr. Nakazawa held a second-class radiophone license issued by the Federal Communications Commission on Dec. 11, 1953.

2. Northrop. Pilot Roland E. Owen, age 36, was employed by the company on Oct. 15, 1951. He was the Chief of Production Test at the time of the accident. He held a valid airman certificate with commercial and instrument ratings. He also held a formal certificate of authority from USAF to fly the F-89. Pilot Owen had accumulated 2,754 flying hours, of which 1,320 were in jet aircraft and 1,249 were in the F-89 type jet. His last physical examination was accomplished in May, 1956, without waivers. His last high-altitude indoctrination was accomplished May 31, 1955 (valid for three years).

Radar Operator Curtiss A. Adams, age 27, was employed Oct. 10, 1951, as an electronic checkout man. His last physical and high-altitude indoctrinations were received in May, 1956, and September, 1956.

THE AIRCRAFT

The DC-7B, N 8210H, had a total of 1:03 flying time since its manufacture. It was equipped with Wright engines, model 972TC18DA-4, and Hamilton Standard propellers, model 34E60-363, blade model 6921A-8. The engines and propellers had accumulated about 14 hr. of ground running time since new.

The F-89 bore manufacturer's serial number 4447 and USAF designation 52-1870A. The aircraft had been flown 261 hr. since manufacture and 6 hr. since IRAN. The F-89 engines were Allison, model J-35A-35. The left and right engines had accumulated 258 hr. and 200 hr., respectively, since new.

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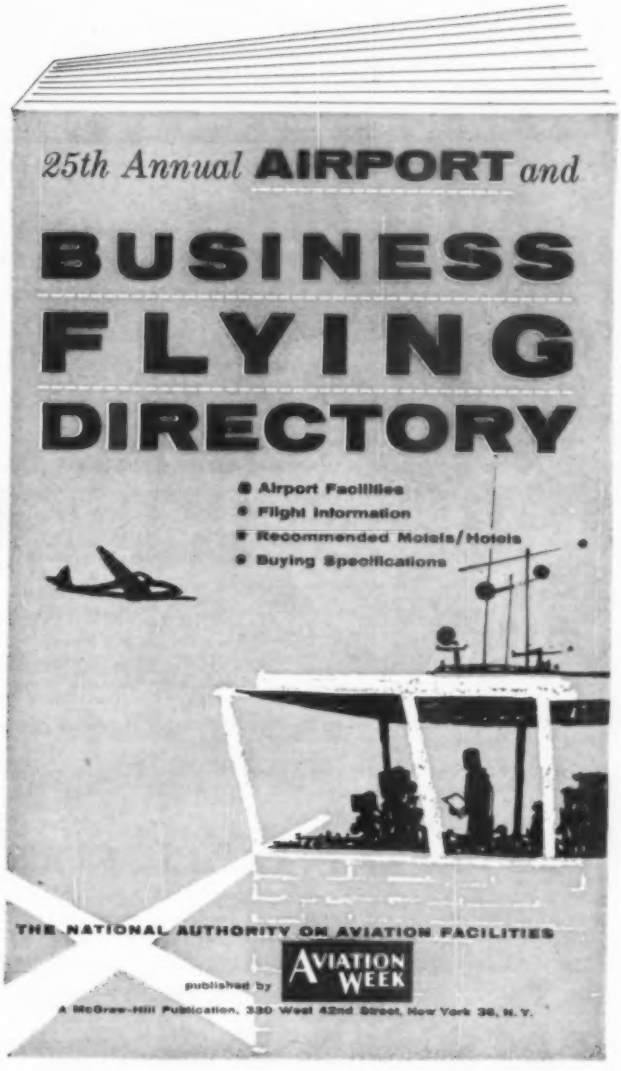

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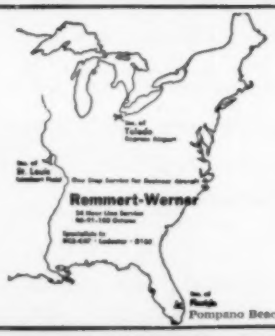

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LETTERS

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BOWYER
Director
Society of British Aircraft Constructors
London

(Ours, too, to Ted Bowyer for his good sportsmanship.—Ed.)

Radiation System

I would like to clarify a point concerning the 60 ft. "Missile Tracker" telemetry antenna (AW Dec. 9, p. 93).

These are telemetry antenna systems which automatically track long range missiles to receive their telemetry signals. The basic 60 ft. antenna, built by D. S. Kennedy & Co., is incorporated into the system by means of a unique conical-scan feed and appropriate servomechanisms and controls. The design and development of the complete system—as well as the installation at the down range sites—was accomplished by the RF Systems Division of Radiation, Inc. We are naturally proud of our part in this significant addition to the AFMTC range instrumentation.

H. W. GETTINGS
Manager
Contract Information and Publicity
Radiation, Inc.
Melbourne, Fla.

In Public Interest

This morning Vanguard exploded, and its reverberations were quickly heard round the world, thanks to a press dedicated to the policy that if the Russians would find it out then the public in the U. S. or Brazil or India should immediately be privy to the fact in all possible detail including quarter hour reports on count down progress, possible valve malfunction, etc. ad nauseam. This evening a local radio reporter averred that "this is a serious propaganda setback." Indeed it was, but primarily only because this amateur pundit and hundreds like him told the world this was so. But it would not be true if these same reporters and news analysts had presented it as factual information undistorted by days of preliminary theatrical background buildup and various specious interpretations of its significance.

In the frenzy created by the press—and I specifically cite AVIATION WEEK—regarding the public right to an ever increasing knowledge of detailed military information, it is apparently forgotten that few persons are technically or politically capable of assessing fragmental or interim reports on technological developments so that rarely are they presented to the public in proper context. The public then is at best confused, at worst apprehensive and alarmed; frustrated by its inability to understand and finally reluctant to place credence in any news source. A more unfortunate corollary of such a policy is the adverse environment imposed upon our scientists and engineers responsible for our work in the missile field. Can you conceive that this is conducive to optimum performance by anyone engaged in such effort?

Gentlemen, this is not a baseball game. And many details of our military developments, even if unclassified, are no more in the public interest than its knowledge of the correction in an umpire's glasses. I sincerely feel that AVIATION WEEK as an acknowledged and accredited spokesman for the aviation industry has been editorially remiss in its consistent thumping for relaxation of restrictions on details of our military programs. With a notable assist from Sputnik, you and others have reaped the whirlwind of irresponsible reporting in the lay press. While you can hardly be indicted for their actions, your culpability must lie in failure to recognize that what is known to the Russians is not license for broad dissemination of such facts, particularly if through naivete they are distorted to an extent in publication that it may become politically prejudicial to our country or detrimental to our scientific effort.

As a responsible technical journal your factual articles show insight and understanding. It is unfortunate that your editorials are not so dispassionate.

J. K. BURKLEY
Cuyahoga Falls, Ohio

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

First Blow

I read with interest Gen. White's comment (AW Dec. 9, p. 29) that: "Least desirable air defense, a 'last ditch' effort, is to fight the enemy after he gets over the target area. The Air Force aim is to keep the enemy from getting off the ground."

This sounds very nice; however, implementation of such a policy would seem to require a change in national thinking since it would obviously require that the Air Force strike the first blow. Is there anyone in Washington to make such a decision?

HENRY C. ALBERTS
Lynnfield Center, Mass.

Comet Electra

May we say how pleased we were on this side of the Atlantic to read that the Lockheed Electra had been rolled out ahead of schedule, as you announced in the caption to the picture of the aircraft on p. 39 of AVIATION WEEK for Nov. 18.

After studying the photograph, we were even more pleased to see that the Lockheed designers have followed the example of Sud Aviation in using a de Havilland Comet nose and cockpit section, indeed, they appear to have gone further even than the admirable Caravelle in that they have followed the lines of the Comet fuselage with praiseworthy exactness, even to having window end door apertures which are a carbon copy of the British machine. It will be a big relief to the de Havilland designers over here to have such flattering confirmation of the soundness of their efforts, and we feel free now to express our opinion that the rather bulbous lines of the Electra as shown in the advertisements, and which we now realize were simply artists' license, were a sad mistake.

M. J. LUND
J. B. SENIOR
L. HOLLINGS
Blackburn and General Aircraft, Ltd.
Leeds Design Office
173 Park Lane
Leeds 1, England

(AW corrected its error on p. 40 of the Nov. 25 issue.—Ed.)

Moon Reversal

Regarding the Dec. 9 issue of AVIATION WEEK magazine on p. 134, your readers may be interested to know that the reversal effect observed in moon photographs has also been observed "live" through a telescope by the writer, which would seem to indicate that the phenomenon is not limited to the viewing of photographs.

DANIEL A. LANCIANI
Microwave Associates, Inc.
Burlington, Mass.

Gravity Experiment

I was very much interested in an item that appeared in the column "Industry Observer" (AW Nov. 25) concerning an "Imaginative gravity experiment being considered by Air Research and Development Command. . . ."

Gravity research is extremely important, particularly right now, because the country which pursues this line of research most intensively at the earliest possible time would stand the greatest chance of achieving a physical control of nature and a psychological, cold-war victory of first magnitude.

Gravitational turbines could run off a truly limitless source of energy—gravity. And the fuel wouldn't cost a cent. Anything that otherwise would have to be lifted at great effort could be done effortlessly with gravity doing the work indirectly.

In particular, it takes little imagination to see how it could revolutionize flight through both the atmosphere and through space. Rocket engines of great power now needed for getting out of the gravitational pull of planets would be entirely unnecessary. Weight would be reduced gradually and centrifugal force would do the rest.

For pilots and passengers there would be no red-outs or black-outs or even any sensation of flight during violent maneuvers. The craft would generate its own gravitational field which would be quite independent from any exterior gravitational field.

RONALD MONROE
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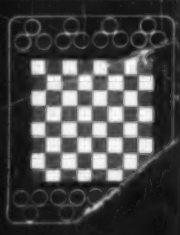

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